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ELECTRIC LIGHTING AS APPLIED TO RAILWAY SERVICE.

To those who have noticed the rapid extension of the electric light in America, and its ready application, amongst other institutions, to railway requirements, the apparent indifference of railway companies in England to its advantages must appear somewhat remarkable. Again and again we are tempted to ask, is it indifference or is there any other reason? We do not think England's railway managers, or those who are more directly responsible for the despatch of business, are indifferent to the requirements of their service. They are men specially selected for the onerous posts which they invariably fill with much credit, for their fitness, their ready business qualifications, and their keen appreciation of the value of time and money. We have seen that the light is employed in the interests of certain companies, so that it is clear its advantages are not kept under a bushel by the electrical departments of the several services. Is it that our large railway corporations are so conservative in principle that they cannot sever their connection with oil and gas? Or is it that the cost, being probably more than that now paid for illuminating a given space, is so much less than that required for the electric light? We are inclined to think this is nearer the point. In many instances we know how apt we are to look at any expenditure which may exceed that which we for the present incur. Railway companies now light a goods shed or a marshalling ground for so much. To establish the electric light will call for a special outlay—perhaps of a sensible sum of money. It will cost in maintenance, possibly, more than is paid for the gas as now used? Where is its advantage?

Those who look at the question in this manner will find in it no advantage; but there is another standpoint from which it may be viewed. We have heard it stated that the cost of a fairly heavy installation for the purpose of aiding the working of an important and somewhat circumscribed goods yard of a London railway depôt was entirely recouped by the suppression of the amount of losses incurred for goods of which the company was annually robbed. Whether this is so or not, we know it to be a fact that so greatly has, and does, the form of lighting now employed aid the working of the yard, that nothing would induce the officials to part with it; whereas, before the work had to be done with a light which practically rendered the darkness more visible, it is now carried on under a light which at all critical points affords an illumination as nearly equal to daylight as artificial light can approach. Trains arrive. The shunter calls for certain roads. Standing near his train, the light shows him the instant the points are set and the road is made. The signal is given to the driver, and in a moment the vehicles for that road are on their way and another road is being asked for to be used in a similar manner. Thus, in ten minutes or a quarter of an hour, is the marshalling or the distribution of a train dealt with, as against a probable hour under the old method of hand and gas lamps. Nor should the question of safety to those engaged in the work be forgotten. Custom, it is said, brings with it contempt. The man who is careful as a new comer, often becomes indifferent to danger the more experienced he grows. With an imperfect light men must, at the best, be always on the alert. With a light which renders clearly visible the approach of vehicles the mishap of a moment should not occur.

Another case, illustrative of the advantage of a sufficiency of light to enable work to be dealt with expeditiously, comes to our memory. The traffic of a large goods depôt, within a hundred miles of St. Martin's-le-Grand, had so increased, that it was found impossible to deal with it during the night in sufficient time to get the trains out before the morning residential traffic took possession of the line. The goods trains were fairly stopping the passenger traffic, and there was no apparently possible way of meeting the difficulty except by increasing the loading accommoda-

tion of the goods station, so as to admit of more vehicles being loaded at a time. This, at the time, was not possible, for the reason that money could not procure the land; had it, however, been procured this form of redress would have involved a combination of the inconvenience till the additional accommodation had been provided. We believe it was due to the ready resources of the goods manager of the line, to which our remarks refer, that the company was delivered from the dilemma in which it was thus placed. It occurred to him to throw more light into the goods sheds and yards, and this he did with no niggard hand. The loading stages and the shunting grounds were, practically, flooded with light. The men worked with freedom; hand lamps were set on one side. The time occupied in handling them was bestowed upon the actual work of loading and unloading the goods. The desired end was secured. The trains were disposed of to their time, and the traffic restored to its normal regularity.

We give these as points in fact, where most important advantages attended the introduction of the electric light, and where, in one instance, it is probable a large outlay for buildings and land was, at all events postponed, if not absolutely saved. They are facts which are probably as well known to the railway companies as to ourselves; and it cannot be doubted that equal advantage might be secured by its employment elsewhere. That its employment effects a saving in labour—in men's time; that it aids despatch; that it is an efficient factor in the suppression of accidents, we think must be clear to all who care to consider its use in the sense in which we have instanced its utility. That it actually costs more than the existing outlay for a very poor and minor light, does not condemn it as more costly in the end. Take into consideration the issues secured, and we question if the advantage is not so greatly on the side of the electric light as to utterly debar any comparison with other illuminants.

Electricity has been of the greatest service to railways. It is difficult to conceive at this moment how the railway work of the country could be dealt with without it. Certain it is that an enormous outlay must have occurred in duplication of lines had not electricity aided in the regulation of the traffic. And it is equally certain that electricity will year by year, and day by day, prove itself, if well and judiciously handled, of still greater service. So many are its applications, so readily does it adapt itself to every requirement, and so exact is its proportionments when in operation, that it readily presents itself to the service of all who desire to avail themselves of it. In the illumination of railway stations, goods depôts, goods yards; in the marshalling of goods trains and in their distribution; in the lighting of passenger trains; in welding, and, possibly, at no distant date, in the operation of machinery now worked by hydraulic power, we see a field of utility great alike to the community at large as, more immediately, to the railway interests. Shortly we may see a large portion of the City of London illuminated by the electric light. It seems but a few years since our attention was drawn to the subdivision of the arc, and now that we are arranging for the permanent lighting not only of our metropolis, but of many of our most important towns, we may fittingly consider what has been the progress on railways?

Practically, railways have done very little. Some few of our London stations—Paddington, Cannon Street, the London, Brighton and South Coast at Victoria, the London and South Western at Waterloo and Nine Elms, Cannon Street, Charing Cross, Liverpool Street, and the Midland at St. Pancras—have been, and may, we presume, now be regarded as permanently lighted. But out of London we find little doing. At Glasgow we have the St. Enoch's, Glasgow and South Western Station and Hotel, the Central Station and Hotel, the Grangemouth Docks (both Caledonian), the Waverley Station, Edinburgh, and the Underground Railway, Glasgow (North British), illuminated by the same means.

In the provinces, Bradford stands forth as a brilliant exception. The Midland Company has recently built a very fine and commodious station here, to which there is tacked on a charming hotel, replete with all the advantages and comforts of the present period. The whole of this station, booking offices, waiting rooms, approaches, parcels office, cloak room, and all other offices, refreshment rooms, as well as the hotel, are lighted by electricity throughout. The station, in this respect, stands unique. It is the only station, we believe, extant, which has been so equipped.

We do not know the reasons which have induced the Midland directors to thus again signalise themselves as pioneers in the application of a great and useful branch of science, but we feel that we do not stand alone in our admiration of an intelligent corporate body thus recognising and testing in an efficient and broad manner the worth of that in which they probably see a promising future. We understand that, in laying down the machinery for this installation, provision has also been made for lighting the new goods warehouse which is to be raised on the ground occupied by the old passenger station. In this installation we have hydraulic and electric machinery, with boilers, all within the same building, so that the utmost economy will be obtainable in labour.

Before leaving the subject of lighting, we must not omit to add that the Midland is also laying down, and will shortly have in operation, one of the largest arc light installations extant—viz., 150 arc lights—for the illumination of the St. Pancras goods depôt and the new goods warehouses and yards adjoining the St. Pancras passenger station.

The application of electricity to the lighting of railway trains must necessarily feel its way, but the efforts made by the Midland to solve the question bear with them every prospect of success. For some years the London, Brighton and South Coast Railway has been running trains illuminated by this means, the dynamo being driven from the axle of one of the vehicles, and the lights being sustained by one set of accumulators arranged in the same vehicle. The experiments carried out by the Midland have taken a wider scope, and have had for their object the

determination whether electricity is capable of being applied to all the exigencies of railway traffic. Thus, with respect to main-line trains, and others, which are not always coupled, *i.e.*, trains *en bloc*—each vehicle carries its own lighting power, accumulators capable, when fully charged, of sustainining the whole of the lights of the vehicle for a given period—say, six to eight hours—being provided in each carriage. So far the Midland has now had running for some time daily out of London two trains for Manchester and Liverpool, and two trains for Nottingham, Sheffield, Leeds, and Bradford; and, similarly, two trains daily from each of the places named to London. These trains, together with a local "bloc" train running between Manchester and Stockport, have the dynamo driven, like the Brighton Company's trains, from the wheels of one of the vehicles on the train. We understand, however, that the Midland is now proceeding a step further, and fitting other trains, driving the dynamo direct from a small engine placed upon the locomotive.

So far train lighting by electricity has been confined to the Brighton, South Eastern, Great Northern, and Midland. With the exception of the Midland there has been no attempt to deal with trains broken up on the journey, or for slipping coaches, &c., on the way. At the same time it is worthy of mention that experiments to a small extent, and extending over a very short period, have been made by the Great Eastern and Lancashire and Yorkshire Railway Companies.

We can only hope that the experiments which have been undertaken, with so much success so far, by the Brighton, the Great Northern, and the Midland, will be pursued to that successful end which will establish so useful and so favourite a form of light for the comfort of the travelling public. Difficulties invariably accompany new applications, and in the application of electricity to the purpose in question there are, undoubtedly, many new phases to deal with. Apparently these have been, so far, so well met as to leave little doubt of ultimate and complete success.

THE HOPKINSON AMENDMENT.

HOWEVER dry the subject matter, the perusal of a pile of statutory declarations furnishes, at times, an interesting and instructive occupation. We have read the Hopkinson Amendment Declarations once more before consigning them to the receptacle reserved for ephemeral literature, and with the evidence before us confess that we can find no fault with the decision of the Comptroller-General. The patent of the Brothers Hopkinson is for "improvements in the construction and application of induction coils," and the patentees applied for leave to amend the above title by specifically limiting their claims to coils used "for electric distribution," these last three words being proposed to be added to the title. The claims were proposed to be narrowed down to two, which included secondary generators having an approximately closed magnetic circuit of laminated iron—three claims for methods of regulation having been excised. The specification appears to have been carelessly drawn up, as it contains several clerical errors, for leave to correct which application was also made. These errors are "contact" for "control," "neutral" for "mutual," and "perpendicular" for "parallel." Many sincere and solemn declarations were obtained by the opposition to show that they were not errors at all but that the words proposed to be used instead of them constituted an afterthought on the part of the applicants. However, the Comptroller-General of Patents has allowed the corrections to be made, the fact that the words in question were verbal errors being perfectly clear from the description and drawings—that is to anyone not an expert witness retained by the opposition. As is well known, the expert witness can display the profoundest idiocy or the sharpest intelligence, as occasion may require. Leave to amend the title has not been granted, nor have the claims been narrowed down. The opposition sincerely and solemnly declares that such amendment would entirely alter the scope and bearing of the patent. Perhaps it would; we are not quite sure, but we don't think so. However, as there is a doubt on the point, the Comptroller has done right in disallowing the proposed amendment. The patentees say that the application of induction coils to electric distribution is clearly implied in their specification, and that this would be understood by any person conversant with electrical engineering who read that document fairly. We say so too, for the frequently employed term "secondary generator" proves this apparatus to be included under the more comprehensive title of induction coil. But this affords no reason for allowing the amendment, and as the scope of a patent admits of more than one interpretation, if there are doubts, they had best be settled in the Law Courts. People who draw up specifications in loose fashion must be prepared for the pleasant contingency of a decision by Judge and Jury.

Electrical Nomenclature.

UNDER the above heading we notice, in the New York *Electrical Engineer* of August 20th, a letter from Professor J. A. Fleming, having especial reference to the proposed connection of the names of Franklin and Henry with the titles of certain electrical units. However much these names are deserving of being held up to admiration, and of being preserved to memory, we think that the mania for inventing fresh terms has been carried to an extreme. Is it not sufficient that the names of Ampère, Faraday, Joule, Ohm, Volta, Watt &c., have been tortured, twisted, and scattered recklessly hither and thither? Must we further submit to an amplification of the already overstocked vocabulary of electrical terms? A veritable craze seems to have taken possession of the electrical world, but there is, after all, an amusing phase of the disease. The writer of the letter above alluded to, suggests that "the practical unit of self-induction in the system of measurement which employs the ampère, volt, ohm, &c., should be called a *hen*." Oh, shades of poultry yards! will not every barn-yard rooster arise and crow out his indignation? The following paragraph—"and bestow upon the unit a name which carries no suggestion of dimen-

sions, and which is susceptible of being used in such compounds as *micro-hen* and *milli-hen* convenient for subdivisions of the unit," seems to us a direct insult levelled at Dame Partlet and her callow brood. The professor goes on to say, "There is nothing to prevent any one speaking of *true hens*, *legal hens*, or *British Association hens*, if it is required to be very precise." What delicate definitions! Should suggestions of the nature proposed by Professor Fleming be generally adopted, an unlimited field is presented to the aspiring nomenclaturist; the possible variations being almost endless, limited only by the number of names borne by men more or less famous in electrical science. But, perhaps, we have taken Professor Fleming's suggestion too seriously.

Electric Light at Bath.

ACCORDING to accounts which have reached us at various periods the electric lighting at Bath is no unmixed blessing. After the installation had been running a short time many complaints were made of faulty lamps; now matters seem to be a little worse. On Sunday night we are told the donkey engine used in the central station to feed the boilers broke down, and the alternators were shut off putting out the incandescent lamps, which were not restarted that evening. Shortly after the arc machines, with the exception of one, were stopped for about three hours, putting out half the street arc lamps and leaving the works in darkness, the men having to work with candles and oil lamps; later on, we are informed, the whole of the public arc lamps were discontinued for an hour. We are afraid this is calculated to bring some one into discredit, whoever that someone may be.

Kemmler's Execution.

WHENEVER we take up an American paper, which is published beyond the sphere of influence controlled by the alternating current party, we find such remarks as the following by no means uncommon: "But the horrible part of the execution, so many papers say, was the fact that the flesh on the top of the head and at the base of the spine was burned, and that death by electricity is therefore a failure." It is very sad indeed to think that a man like Kemmler, who was devoid of all that pertains to humanity, should be slightly burned. This little preface to his hereafter should be considered simply as a preliminary that he might become to some degree accustomed to his future state, and we believe that a continuance of the law which made death by electricity legal will have a salutary effect upon the criminal class in New York State, and that other States might do worse than adopt it.

Elmore's Copper Companies.

THE *Financial News* of September 3rd recalls its words of June 11th, to the following effect:—"Next to the rise and fall of the Paris Syndicate, the most important event which has happened in the copper trade of late years is the discovery of the Elmore copper-depositing process," and adds: "When the Société des Métaux fell to pieces, M. Secrétan was under contract to buy the foreign patents for £700,000. Two official statements have just been published respecting the relative estimated value of the shares in the English and Foreign Elmore's Copper Depositing Companies. It is pointed out with regard to the former that the plant now in process of completion will yield a profit of £174,720 per annum, enabling the company to pay a dividend of 100 per cent. and leaving a surplus of £34,720. It is deduced from this that the shares which now stand at about £7 should be worth £20 each, and Mr. Elmore says that 'at no very distant period they will stand at £50 each.' The shares in the Foreign Company are estimated on the basis of the sale of four groups of patents now in negotiation, the total anticipated receipts from which amount to £566,500, giving £17 each to the priority shares and more than £34 each to the founders' shares, apart from the value of shares in subsidiary companies." The above predictions are very pretty, and doubtless will send a warm thrill of excitement through the holders of Elmore copper shares, but they must, of course, be taken with a grain of salt. We sincerely hope the forecasts will be verified, and that the example of the Société des Métaux may not be followed, for with success no one will be harmed. We should, however, much like to get at genuine manufacturing results rather than the price rigging through means of vague statements of immense profits.

Bleaching by Electricity.

THERE was a paragraph in last week's *Engineering* which a practical bleacher informs us could only be made by an enemy to bleaching by electrolysis or a promoter of the Chemical Union. Our correspondent is ready to prove that such results as those reported would be much dearer than bleaching by chloride of lime, and would condemn the electrolytic system if nothing better were done. He encloses us the following letter from the London Electric Bleaching Company to a Manchester firm, and expresses his readiness to conduct the experiments in the presence not only of paper makers but of the representatives of the electrical press:—

Bleaching by Electricity.

Dear Sirs,—Referring to our former correspondence, we intend next month to demonstrate on a commercial scale the superiority of our process for bleaching by electricity over the present method by means of bleaching powder. By our process, each manufacturer can produce the quantity of bleach he requires daily, without any more trouble than in preparing the solution of bleaching powder. The plant and machinery are not expensive; and are easily adapted to the present system. The bleach produced by electricity has the same decolorising properties as chloride of lime, and none of its drawbacks. By our electrical process bleachers will be enabled to produce the equivalent of a ton of bleaching powder, at *half the present cost*. Our demonstrations (*which will last a fortnight*) will show, 1st. The transformation of common salt and water into bleaching liquor of the required chlorometric strength for the ensuing operations. 2nd. The bleaching of a *few cwts., or say half a ton of paper pulp, or of vegetable fibres, in less time, and at half the cost*, as compared with when bleaching powder is used. Kindly let us know if you will favour us with your presence, or with that of your representatives, and as soon as our installations are completed, we shall let you know the date of our experiments; and, if you wish it, we will bleach your own materials.

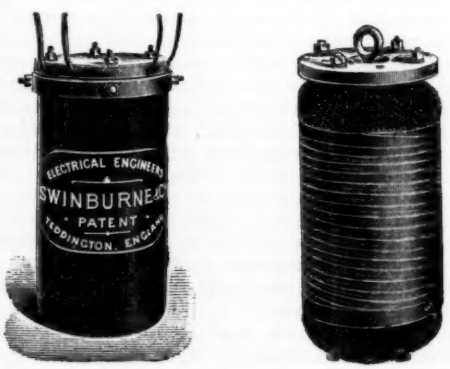
Electric Lighting in Birmingham.

IT is probable that big things may be expected in the way of electric lighting at Birmingham very shortly. Already a good many street mains are laid in the central portion of the town, and the work is being rapidly pushed on. The company responsible for this is the Birmingham Electric Supply Company, which had the provisional order transferred to them by Messrs. Chamberlain and Hookham last year. Their order enables them to supply the electric light to the richest neighbourhood, in which are all the public institutions, theatres, banks and offices. It is expected that a station will be erected capable of supplying 20,000 lights. It is high time that the chief town of the Midlands bestirred itself to acquire a good system of electric lighting; private lighting has been carried on, but only in one or two of the theatres and other buildings. It is, therefore, with satisfaction we hear of the work likely to be accomplished by the local company.

THE HEDGEHOG TRANSFORMER.

LAST year Mr. Swinburne brought forward the theory that an open iron circuit could be made more efficient than any form of closed iron circuit transformer. The loss in a transformer is made up of loss in copper due to resistance and the loss in iron due to hysteresis. In calculating the efficiencies of transformers, the loss in the iron has generally been left completely out of account, and the loss in copper alone considered. Hence the efficiences of 97 and 98 per cent. claimed for closed iron circuit forms. If the loss by hysteresis is taken into account, allowing the losses as given by Ewing, the loss in iron in closed circuit transformers, as usually designed is some 10 per cent. of the full load. As the loss in iron goes on all the time a transformer is in circuit, this is very serious. The proportion of actual to possible output of energy per day varies in different districts, but in most stations the average use of lamps is less than two hours a day, including all the lamps installed. The transformer must be large enough to feed all the lamps installed, so it runs, say, an average two hours of full load a day. If there is a loss of 10 per cent. of full load in the iron, this gives an actual efficiency of 45 per cent., even neglecting the loss in copper. In the Hedgehog form the proportion of iron is very much reduced. The cross section of the iron is much less, and the length is about one-third of the closed circuit form, as it has not to surround the wire. The result is that, even in small transformers, the iron loss is under 1 per cent. of the full load. One per cent. of the full load gives 89 per cent. all day, neglecting copper loss, against the 45 per cent. of the closed circuit. This is neglecting copper, however, and the copper loss is greater in the Hedgehog form, so this is an exaggerated comparison. Such a transformer really has an efficiency of about 87 per cent. all day.

The theory of the Hedgehog form is this: If a closed iron circuit is used, the iron circuit must be long, to embrace the copper coils. The only way to shorten it is to make the copper coils smaller. This means using a higher current density which, is wasteful, or fewer turns of copper. Fewer turns of copper demands either



a higher induction in the iron, or a greater cross section, and both of these mean greater loss by hysteresis. If the iron circuit is opened, the sides of the embracing core can be removed, so the loss by hysteresis is divided by three. As there is now plenty of room for copper, the turns and cross section can be increased, and the iron reduced still further. The object of introducing the closed iron circuit was to reduce the magnetic resistance. An open circuit transformer has much higher magnetic resistance. The question of magnetic resistance is not so important as might at first sight appear. Its increase demands more excitation, or more magnetomotive force, and this increases the loss in copper. The best form is thus a compromise. The Hedgehog ends are to reduce the magnetic resistance. In a conductive circuit the resistance is low, if the current density is low in all parts where the specific resistance is high. Similarily, in a composite magnetic circuit of iron and air, the magnetic resistance is low if there is never a high magnetic current density or induction in the air, which has high specific magnetic resistance. The magnetising current in a Hedgehog is high; but as it is a quarter of a period behind the primary current in phase, and as the primary wire has to be large enough to carry the primary current, the loss in watts is small. As this loss goes on all day, however, it is by no means unimportant, and has to be included in getting out the efficiencies of these transformers. The construction of these transformers, as carried out by Messrs. Swinburne and Co., of Teddington, is very simple. A gun metal casting of cross shaped section forms the backbone. It is spread out at each end, forming legs at one, and taking the circular terminal board at the other. It also carries insulating flanges which form the ends of the coils. Into the four recesses in the core are put four bundles of soft iron wire. These are taped over, and the secondary is wound on. The secondary is then covered with two layers of ebonite, and the flanges are also faced with the same material. The primary is then wound on in two compartments, separated with ebonite after the manner invented by Gramme, so that both ends come outside, and as far removed from each other as possible. The ends of the core are then spread out, and the transformer tested under 4,000 or 5,000 volts; the insulation in meghoms being read by a peculiar instrument which measures the effective resistance under an alternating current. As iron cases cannot be used, as they would be magnetised by the transformer, and as any metal would have Foucault currents generated in it, stoneware jars are used for cases. These have lids bolted down with holes for the leads, as shown.

ELECTRIC LIGHTING MANY TIMES SUPERIOR TO GAS.*

By PAUL HOHO.

AT a conference which took place in connection with the last general assembly of the Union of Engineers graduated at the University of Louvain. I had occasion to make a comparison between certain figures relative to the yields of an electric incandescent lamp and a jet of gas. I was greatly surprised at the astonishment which my conclusions evoked, even amongst electricians; and I was induced thereby to repeat my calculations in our society with a view to raising a discussion so as to accentuate the affirmative character of the conclusions which might result. In any case it is well to proclaim aloud and to reiterate figures which ought certainly to find a place on the leading page of every engineer's pocket book. The matter is one of extreme simplicity and, frankly, I ought to apologise to you for introducing one so elementary.

The entire question reduces itself to this: What amount of energy is required by an incandescent lamp on the one hand and a gas jet on the other, in order to produce an equal amount of light, for example, an amount equivalent to 16 candles?

Allow me to make a slight digression for the purpose of assisting somewhat in preparing gas for the sentence which is about to be pronounced upon it by figures which admit of no appeal.

The action of the incandescent lamp is based upon the fact that the energy of the electric current in traversing its filament is transformed by reason of the resistance offered by the latter, into calorific energy, which emanates from the filament in the form of calorific rays. But, as you are aware, a solid body if placed in a certain temperature becomes incandescent, that is, a part of the calorific rays becomes luminous.

* A paper read before the Société Belge d'Electriciens.

For the complete utilisation of this property it would be necessary to attain to such a temperature that the proportion of the luminous rays to the total radiation is the maximum. Unfortunately the physical constitution of the filament, as we actually possess it, does not admit of its being placed above a certain temperature, and we are compelled, therefore, to moderate the action of the electricity in the lamps. The incandescent lamp, as far as it goes, is consequently very far from realising our ideal, and in order to bring about its perfect action upon this principle, electricity is compelled to await the progress of chemistry, which I hope will one day give us a body upon which electricity will be able to exercise its action without restraint. I will not expatiate upon what may be reasonably expected by electricity upon this head, but will base my calculations upon results as they have been actually obtained.

As regards the gas jet, I would first of all remark what a singular idea was that which sought to light up the universe by means of a flame. A flame, as you are aware, is essentially composed of gaseous elements, in which is found a comparatively slender quantity of solid particles. Now, we learn by physical science, that from gas, at whatever temperature it may be carried, emanates very little or no light; all its rays are calorific, and the light which emanates from the flame, is exclusively composed of solid particles, notably carbon.

Is it possible to imagine a more irrational method of lighting? You may attempt to excuse it by saying that it has for a long time been the only one we knew. I admit the excuse, and even that it is a serious one, but you must also confess that it is the only one.

A priori, we are in a position to foresee the wretched result to be had from a gas jet; and it only remains to compare the figures.

An incandescent lamp of 16 candle-power consumes at its terminals 2, 2¼, 2½, 3 to 3½ watts per candle, or, 32, 36, 40, 48 to 56 watts for every 16 candles, which amounts to 3·2, 3·6, 4, 4·8, 5·6 kilogrammetres per second for every 16 candles.

On the other hand, a 16 candle-power gas jet consumes 180 litres and more per hour.

Now, a cubic metre of gas, by its combustion, gives out 6,000 calories (according to M. Fresca's calculation); and 180 litres will give out $6{,}000 \times \frac{180}{1{,}000} = 1{,}080$ calories; 1,080 calories = 1,080 × 424 = 457,920 kilogrammetres, which a gas jet consumes per hour, that is $\frac{457{,}920}{3{,}600} = 127{\cdot}20$ kilogrammetres per second.

It only remains now to compare this consumption of energy with that of an incandescent lamp as set out below.

$$\frac{127{\cdot}20 \text{ kilogrammetres}}{3{\cdot}2} = 39{\cdot}75;$$

$$\frac{127{\cdot}20 \text{ kilogrammetres}}{3{\cdot}6} = 35{\cdot}28;$$

$$\frac{127{\cdot}20 \text{ kilogrammetres}}{4} = 26{\cdot}50;$$

$$\frac{127{\cdot}20 \text{ kilogrammetres}}{5{\cdot}6} = 22{\cdot}70;$$

From these I conclude that in order to produce a luminous intensity of 16 candles, a gas jet consumes 22·71 to 39·75 times more energy than an incandescent electric lamp, counting the latter at 2 to 3½ watts per candle, and the consumption of gas at 180 litres per hour. I conclude, further, that the incandescent supplies an illumination absolutely 22 to 40 times that of a gas jet.

That is all I had to prove, and I could content myself with pointing out that in order to destroy these conclusions it will be necessary to invalidate the preceding figures, which is, I repeat, impossible. However, as I foresee myself being answered in the eternal refrain of "theory and practice," I will dwell a little longer upon the matter than it really demands.

In the above conclusion I have specified all that the figures teach; they tell us nothing more, but, above all, nothing less. We therefore have it that the incandescent lamp constitutes a transformer for the production of luminous energy 22 to 40 times more perfect than the gas jet, comparing the two individually without regard to the production of energy by the one, or of gas by the other. This is the first thing to be established.

Next, as regards the production of electric energy and the production of gas.

Energy is present in nature under various forms; under that of chemical energy in carbon and other bodies—as calorific energy, as the energy of gravitation and of masses in movement, for example, the fall and flow of water.

Gas can only be obtained from coal, and, in certain cases, where it already existant in nature, whilst it cannot be drawn from energy which exists in other forms unless in the most roundabout and impossible way.

Electric energy, on the contrary, may be obtained by the transformation of energy existing in any form, with various results. Thus coal may be transformed into electric energy by a series of transformations yielding a feeble result which is successively diminished by each transformation; the mechanical energy which may be employed upon a shaft moved by a fall of water, may be transformed into electric energy and afford results unknown in any other industry, 85, 90, and even 93 per cent., for instance.

Therefore in comparing electricity with gas, it would be absolutely unreasonable to deal with energy as existing under one form only.

If gas, for the sake of a cause which is otherwise indefensible, demands that the comparison be made from the standpoint of the energy of coal compared with that of gas, electricity will not shrink from the comparison; but should electricity in its turn call for a comparison with other forms of energy, the protests of the advocates of gas would only be equalled by the disastrous results to their client.

However, for the production of light, it suffices on principle to have a suitable transformation of energy, nothing but energy, and this as much as possible free from carbon fumes and from the emanations of carbonic acid and other similar products whose influence is little beneficial. It is true that coal is to be found in large quantity in nature, and that in this country, as a rule, it offers the most economical and convenient form of energy for our needs. But we are not merely arguing the case of Brussels, and without admitting the hypothesis that some day or other we shall have to make use of the Niagara Falls, we have still in this country waterfalls and flows which could be easily utilised, and which have, in fact, been so very frequently.

We by no means decline to institute a comparison with gas on the standpoint of coal or of gas even, but first let us point out the insufficiency and exclusiveness of the comparison.

Thus, 10 kilos. of coal furnish a maximum of 3,000 litres of gas, or a quantity sufficient to feed ten jets of 16 candle-power during one hour and forty minutes. To produce electric energy from coal, we are obliged in the first place to transform, by a series of transformations, the energy of coal into mechanical energy and next into electric energy. With the aid of a good condensing engine, 10 kilos. of coal will furnish 8 horse-power hours upon the shaft, by means of which the dynamo electric machine will furnish 8 H.P.H. × 75 kg. × 9·8 w. × 80 per cent. = 4,800 watt-hours, or the amount of energy necessary for supplying 10 incandescent 16 candle lamps during 8¼ths to 15 hours.

Result in favour of electricity:

$$\frac{8\frac{1}{4} \text{ to } 15}{1\frac{1}{3}} = \frac{5\frac{1}{4} \text{ to } 9}{1}$$

and, moreover, the first transformations of the energy, up to the driving shaft, before electricity had come into play, had only furnished a total rendering of 10 per cent.

In fact, 1 kilo. of coal gives an immediate yield of

5,000 calories = 2,120,000 kilogrammetres, whereas upon the driving shaft we have 0·8 H.P.H. × 75 kg. × 3,600 *s* = 216,000 kilogrammetres, which gives a rendering of $\frac{216,000}{2,120,000} = 0{\cdot}10 = 10$ per cent.

Let us now make the comparison on the score of gas, that is, by employing the 3,000 litres of gas produced by 10 kilos of coal on the one hand directly in the gas jets, and on the other for producing, by means of various transformations, electrical energy for the supply of incandescent lamps. The 3,000 litres of gas will supply, it is said, 10 jets of 16 candle-power during one hour and 40 minutes. On the other hand they will supply upon the driving shaft of a gas motor $\frac{3,000}{700} =$ 4·286 horse-power hours, by means of which the dynamo will furnish 4·286 H.P.H. × 75 kg. × 9·8 w. × 80 per cent. = 2,560 watts hours, or the amount of energy required for supplying 10 16-candle incandescent lamps during $4\frac{1}{7}$ to 8 hours.

Result in favour of electricity

$$\frac{4\frac{1}{7} \text{ to } 8}{1\frac{2}{3}} = \frac{2{\cdot}74 \text{ to } 4{\cdot}8}{1}$$

And, moreover, the gas motor, which consumes 700 litres of gas per horse-hour only returns 15 per cent. yield. In fact 700 litres of gas give immediately $\frac{700}{1,000} \times 6,000 = 4,200$ calories $= 4,200 \times 424 =$ 1,780,800 kilogrammetres; whilst on the driving shaft they gave 75 kg. × 3,600 = 270,000 kilogrammetres, or

$$\frac{270,000}{1,780,000} = 0{\cdot}15 = 15 \text{ per cent.}$$

These figures point their own conclusions sufficiently clearly, precisely, explicitly and instructively to be developed by us.

I have only to point out what follows as a consequence:

1. The loss which occurs in obtaining electric lighting by means of coal or gas, is not to be attributed to electricity but to the successive transformations of energy with very slender results, before electric energy is obtained.

2. Directly electricity comes into play, that is when mechanical becomes transformed into electrical energy, the yield is enhanced to 80 per cent. (as mentioned in my calculation), and may in fact reach to 85, 90 and 93 per cent. and more.

3. Therefore in spite of the preliminary very unfavourable transformations electricity, a total result is obtained which is notably superior to gas, as I have shown in the foregoing figures.

These will be found to gain in importance and to accentuate the advantages of electricity if we take into consideration the following three facts:

1. The transformation of energy in general in all these forms makes continuous advances. Whilst these advances constitute an immediate advance for electric lighting, they bring with them no advantage for gas lighting. It is true that gas is in no way prejudiced by the transformations undergone by it before its utilisation, but its failure consists entirely in its employment as a lighting medium.

2. The transformation of electric energy is making rapid progress. The same cannot confidently be said of gas, which after over a hundred years of use, finds itself already outstripped by a luminant which hardly counts an existence of 10 years.

3. Electric energy is peculiarly transportable from long distances, a fact which enables it, and will enable it, to overcome local circumstances disadvantageous to its production, by enabling its production in localities where the conditions are more favourable.

Copper in America.—A representative of one of the largest copper houses in America says the demand for copper wire is beyond the wildest hopes of the manufacturer.

PROGRESS OF TELEGRAPHY IN AUSTRIA.

[FROM A CORRESPONDENT.]

RECENTLY an improvement in the Morse apparatus has been effected by means of an invention made by Joseph Stulc, of Jägerndorf, the manager of the Moravia-Silesia central line. This invention is not an improvement or a simplification of the Morse apparatus itself, but it promises noteworthy results as regards economy of working material. The idea upon which Stulc has effected his arrangement of stations is founded upon the division of the current and upon its insulation. He has arrived at the important result that local batteries can be definitely dispensed with in telegraph working. This is an important advantage in the large telegraph systems of the Government, and in railway lines with many branches, as it involves a great economy of material, and dispenses with the trouble of filling up the batteries and exchanging those which have become unserviceable.

With this invention, which has been arrived at in a very simple and ingenious manner, involving no extra outlay, there are connected other advantages of much importance, especially on railways which have to maintain separate batteries to work signals (bell signals and distance-signals). Thanks to the idea of Stulc, which has been tested experimentally, an economy in working material of nearly 50 per cent. has been attained with a current which does not exceed the normal strength.

Of not less importance is the advantage of the same idea in subdividing the current, as Stulc has succeeded in working with a different strength of current. It often happens that the line current, from different causes, is weakened to such an extent that the Morse apparatus gives only illegible signs, whether because the two stations corresponding with each other are too far apart or that various intervening stations disconnect their arrangements on the approach of a thunderstorm. Stulc has met this difficulty in a most satisfactory manner.

It must further be noticed that Stulc has devised a certain method of protecting the telegraphic stations from lightning.

Another not less surprising success of the same inventor is that he has rendered it practicable not only for stations of the same portion, α, of the main line, A, to correspond with the stations of the branch line, B —which is nothing new—but also the stations of the portion, β, of the main line, A, may speak with the same branch line, B, a result which has hitherto been impracticable. This is important, for, in the first place, the communication of messages through intermediate stations is a waste of time; and, in the second, it increases the chances of error. Finally, it must be mentioned that Stulc has encountered a misfortune at the very outset. In his delight at the success he opened heart and mouth to a specialist. The latter, abusing his confidence, applied for patents in Austria and Germany. This affair has occasioned an investigation which may possibly have to be decided by the courts of law. Fortunately the "good friend" has not fully grasped the idea of Stulc, so that there are many important defects in the scheme of the patentee. Herr Stulc has received many offers of financial assistance from patent offices abroad.

WHAT CONSTITUTES A DANGEROUS ELECTRICAL CURRENT?*

By NELSON W. PERRY, E.M.

PART II.—CONCLUDED.

THE average normal resistance of an adult body from hand to hand may be accepted as 1,000 ohms. As the highest estimates have usually placed the quantity ne-

* *Western Electrician.*

cessary to kill at not more than one ampère, if passed from hand to hand or head to foot, the electromotive force that must be associated with the same idea will be 1,000 volts, because the pressure is capable of forcing just one ampère of current through a resistance of 1,000 ohms. We must not, however, assume from this that all currents of 1,000 volts that pass thus through the body are necessarily fatal, because currents may exist of vastly greater electromotive force but lacking in quantity—such as, for instance, the spark from a Leyden jar, which may be many thousand volts, and yet be so insignificant in quantity as to permit of its being taken without unpleasant effects. Then, again, if we should assume a case in which, say, a single ampère of current would only be just sufficient to cause death, it is not to be taken for granted that death could not be caused in any way by *less* than one ampère.

Prof. Tait and Balfour Stewart, in their joint work, "The Unseen Universe," call attention to the different effects that may be produced by the same amount of energy when applied in different ways, and cite as an illustration, that a pillow weighing 30 lbs., moving at a rate of 10 feet per second, that is a velocity it would attain if it had fallen a little less than 2 feet, has nearly the same energy as a pellet of No. 1 shot as it leaves the muzzle of a fowling piece. "How different the quality of these equal quantities of energy of the same kind," say they.

Then, again, it is observed that a force suddenly applied will often produce very different results from an equal one that has been gradually applied, and an interrupted or alternating current of electricity is found to produce more violent physiological effects than a continuous or steady current of the same electromotive force.

In the present state of our knowledge, it is not possible to arrive at the increased effect quantitatively, but that there is increased effect is a matter of very common experience. Mr. Edison is quoted as having stated that three volts of the alternating current would be fully equivalent, in physiological effects, to eight volts of the direct current. Mr. Westinghouse would probably not admit that there was anywhere nearly so much difference between the two.

It is desirable that we do not here confuse the effects due to the breaking of a circuit.

Everyone is familiar with the thumping that occurs when the water is suddenly turned off in a long pipe. There is no jar when the water is turned on at the faucet, but if the pipe is very long, and the water is under considerable "head," a sudden turning off of the flow may result in such a thump as to burst a pipe capable of withstanding a very much greater pressure than that due to the head of water. In fact, this extra pressure, due to the sudden stoppage of a flow of water, is utilised in the hydraulic ram to force water higher than its source.

Now, in the flow of electricity, we have an exactly similar phenomenon. While the sudden closing or starting of an electric current will produce momentary physiological or magnetic effects in excess of the same current more gradually applied, its electromotive force is not increased by its sudden starting; but if a circuit be suddenly broken, we have effects exactly analogous to those observed in the case of water in a pipe. If the wire be very long, these increased effects become more apparent, and, if the long wire constituting the circuit is coiled many times around a soft iron core, as in the case of an electro-magnet, the voltage may be enormously increased by the breaking of the circuit. This effect, which is said to be due to momentum in the case of water, is called the "extra current," and is ascribed to "self-induction" in the case of the electric current.

In some cases this extra current may be several times as strong as the normal current, and it thus becomes apparent how an otherwise harmless current may become an agent of death.

For instance, where a man might catch hold of a broken trolley wire carrying a current of 500 volts with safety, if it were merely hanging down and not touching the ground, he would in all probability be instantly killed if he found such a trolly wire lying on the ground and he should pick it up, because in the first case he would be merely completing the circuit through his body to the ground of a current that is usually considered safe, and in the other, by breaking such a circuit already completed, he would get the benefit of the "extra current" which might be several thousand volts.

It may be laid down as a very safe rule to follow, therefore, to be always suspicious of every wire one meets with in these days, but be especially suspicious of every wire one finds lying on the ground. It is harmless there, but it may be exceedingly dangerous to lift it up. If it is a charged wire, and one can never be sure that it is not, it is sure to be more dangerous to handle than its normal current would imply.

While a dose of electricity not sufficient to kill is exceedingly painful, as the writer and almost every other electrician knows by experience, it is perfectly certain that a sufficient dose is perfectly painless.

Jules Verne, in his story, "A Journey to the Moon," places his heroes in an immense projectile, which is fired at the moon from a cannon of suitable proportions. After the projectile has started on its journey, the hero is at first mystified by the fact that he has heard no report of the explosion. He refers to his figures, and finds that, according to his calculations, the projectile should have an initial velocity greater than that of sound. He concludes, therefore, that he could not have heard the explosion because he has kept ahead of the sound.

A little over a year ago the writer, by invitation, formed one of a select audience of gentlemen before whom Prof. Maybridge showed with the lantern a series of instantaneous photographs. In order to make the intervals between the exposures as well as the times of exposures exceedingly short, the plates had been exposed and stopped by means of an electric current.

One very interesting series of pictures that he showed was intended to illustrate the slowness of the brain in receiving impressions. To illustrate this, he had employed two women—one stood in a bath tub and the other stood upon a chair and poured a bucket of water over the former's head and shoulders. In order to make the shock more intense, Prof. Maybridge had had the bucket filled with icewater, unknown to the victim, who would scarcely have consented to the ducking had she known the temperature of the water. One view represented the water tipped over, and the water falling, but not yet quite touching, the girl's head. The next view showed the water already splashing from her head and shoulders, but although the water had already touched her, and some of it had splashed off from her shoulders, still she had not yet received the sensation.

The third picture showed her just beginning to respond to the shock, and the subsequent ones illustrated the various phases of this response; but what interests us here in this connection is the second view. The electric current had in that case first exposed the plate, and then after a very short interval had shut it off again; that is to say, had acted twice with an interval of time between the two sufficiently long for the sensitive plate to take an impression of the view, and this after the icewater had touched the woman's shoulders, and *before* she was conscious of it.

This is the reason that death by electricity if applied in sufficient doses must be absolutely painless, that with the velocity of light, or at about 186,000 miles per second, the impulse has gone on its way and completed its work. In fact, there are reasons for believing that death by this means is so swift that the dose could be repeated a number of times within the interval that is known to elapse between the receipt of an injury and the cognizance of it by the brain.

In receiving an electric shock it makes a very great difference how we have come in contact with the current, and in accidental cases it is almost impossible to tell just what the conditions were, and consequently how

much current passed through the body. For instance, let us take an ordinary arc light circuit such as are common in all of our cities. Such a circuit carries a current usually of 9·6 ampères at a pressure of 45 volts. I speak of this kind of circuit because in the popular mind it is considered particularly deadly. One may catch hold of the bare conductor with both hands without feeling the slightest shock, because then the body forms what is called a "derived circuit" of high resistance, while the wire between the hands is of very low resistance. The law of flow in such cases is that the current will divide itself among all paths to which it has access in proportion to the conductivity of those paths. In the case just cited the conductivity of the wire between the hands may be 5,000 times as great as that of the body, and in that case 5,000 times as much current would take that path as the other, leaving $\frac{96}{10000}$ths ampère the quantity that would pass through the body —a quantity so small as not to be perceptible.

If one placed his hands on the wire so that a lamp came in between them, the resistance of the lamp would be added to that of the metallic path, and its conductivity would no longer be 5,000 times as great as that of the body—it would be less, and therefore a greater proportion of the current would pass through the body than in the first case. The greater the number of lamps "short-circuited," as the technical phrase is, the smaller the proportion of the current that will follow the wire, until if so many lamps and other resistances are included between the two hands that the resistance of that part of the current is as great as that of the body, then half the current will pass through the body, and half will follow the wire.

It might be perfectly safe, therefore, to catch hold of both of the wires of the so-called deadly arc light circuit if one were sufficiently far from the dynamo so that there were but two or three lights beyond him, whereas it would be surely fatal to do the same thing near the dynamo, where, by so doing, one would short-circuit many or all of the lamps on the circuit as well as the resistance of the circuit itself.

In practice, however, it is never safe to touch even one of the bare wires of such a circuit unless perfectly insulated from the ground, for the reason that there are liable to be leaks or ground connections somewhere along the line, and by touching one wire, while standing upon the ground, a path would be opened for the current from the point touched through the body and the earth to the leak, thus short-circuiting all of the resistances between the two points.

It is therefore another safe rule to follow—never connect two points of an electric circuit between which there exists a high resistance of any kind, by means of the body, as the high resistance forms an obstacle to the passage of the current through that conductor, and forces it to take any other paths open to it.

In the case of a shock by coming into contact with an arc light wire, while in more or less perfect electrical connection with the earth, it is always due to an earth connection somewhere else on the line. It is not infrequently claimed in such cases that the shock received is due to the full force of the current, which in many arc light circuits runs up to 3,000 volts or over. This, of course, is seldom true. In fact, in such cases it is usually utterly impossible to tell just what current was received; first, because the exact location of the leak or leaks on the line is usually never known at the time of the accident, and therefore it is impossible to tell just how many lamps or other resistances have been short-circuited; and then, in the second place, the normal resistance of the body is usually not the only one concerned in the short-circuit—there is the undetermined resistance of the boots, and also of the ladder, or whatever else one is standing on, and also the resistance due to imperfect contact with the wire as well as that of the leak itself. Since the quantity of current that will pass through the body is dependent upon all of these factors which are usually undeterminate, any statement as to what current a man received under such circumstances is at best the merest guess, and usually the poorest kind of a guess at that. We now see, however, how one man may be killed and another be only slightly injured from contact with the same circuit.

The case would be somewhat different, however, if, having hold of the conductor with two hands, it should become broken between the points at which it was grasped. The body would then be virtually short-circuiting an infinite resistance, and would receive the full current of the machine up to the capacity of the machine to force it through his resistance. That portion of the circuit nearest the dynamo would be more dangerous to try the experiment on than that portion furthest removed—in fact, there would be no difference where it was tried; it could have but one result in the case of machines of large capacity, viz., death. The various high resistances which different investigators have attributed to the human body, aside from the other modifying causes that I have shown, make it apparent how possible it is, under circumstances otherwise apparently favourable, for a person to receive a very slight shock comparatively from a very strong current.

On the other hand, several electricians have testified that they have taken currents of very high electromotive force—one in particular testifies to having taken 10,000 volts, and the fact that he lived to tell it is evidence enough that it was not fatal. I have no reason whatever to doubt that it was so, and if there were any object in doing it, or rather if there were sufficient object, I would not hesitate to take myself an alternating current of the same or even greater voltage. I should want to take it in my own way, however, and I could do it without fear of fatal effects, whereas I should feel sure of being instantly killed if I took one ampère of current at 1,000 volts from hand to hand, or from head to foot in the most approved way.

Another feature that has undoubtedly been a very potent factor in the discussion of this question of the uncertainty of the physiological results from the electric current should be referred to. In 1888, the State of New York enacted a statute substituting death by electricity for death by hanging. Any change so radical as this would naturally have attracted wide attention and given rise to considerable discussion, and indeed, with the information then at hand as to the behaviour of the human body towards electricity, there seemed ample grounds for a difference of opinion not only as to the advisability of the change, but also as to the practicability and certainty of the new method. Of course, none of the manufacturers was willing to have his machine used for this purpose. The electrical journals of the day teemed with contributed and editorial comments favouring the views of the manufacturers, and the validity of the law authorising the execution of criminals by electricity was severely attacked, and not allowed to rest until affirmed by the highest court. The electrician, through whose instrumentality the machines were procured, and other arrangements for the carrying out of the law were made, was professionally ostracised and branded with most opprobrious epithets, and every endeavour made to manufacture a public opinion against which it would be impossible for such a law to stand.

The company, whose machines were procured, is the one that has been most active in the introduction of what are known as high potential alternating currents. Their business rivals, who confine themselves to the use of the direct current usually at lower potentials, were not slow to take advantage of what appeared to them a business opportunity, and we therefore have seen arrayed against each other the representatives of the two systems—the high potential, and especially the alternating current representatives—trying to defeat the execution of the law, and using every argument that presented itself to prove the extreme variability of the resistance of the human body, and therefore the uncertainty in any given case as to the probable action of a given electromotive force, and the low potential men endeavouring to prove the necessarily dangerous character of all high potential currents in general, and of alternating currents in particular.

Thus we have had the leading representatives of the two systems appearing in print in one of our leading periodicals, each showing the harmlessness of his own system, and the dangers of the other, and each suggesting a series of precautions, which, if observed, would reduce the danger from electrical currents to a minimum, in a way perfectly satisfactory, doubtless, to himself, but not to the other, because in each case the following of the suggestions of each necessarily involved the abandonment of his opponent's system.

Since perhaps the majority of electricians actively engaged in this country are identified with either one or the other of these two great interests, we find them, too, taking sides—usually with the interest with which they are connected. The old saying that "the wish is often father to the thought" is not merely a pleasant jingle of words, but a psychological fact, and we thus have had most sincere arguments on both sides of the question by men who intended to be and were thoroughly honest.

As a person who is identified with neither party, and yet who has business affiliations with both, I have thought that I could discuss the question free from the bias that has naturally existed in many other instances, and my conclusions from the facts and evidence at hand are, that a large majority of those who are free to weigh the evidence dispassionately are in no uncertain mind that a single ampère of current passing through the body from hand to hand or from head to foot is as surely fatal as anything we know.

I also believe with a great many who have given this subject much thought that a very much less quantity than one ampère would be sufficient to insure immediate death. I have little sympathy, however, with the attempt that has been made to distort the facts in the case to the injury of the business of one of our largest electrical interests, or with that other attempt to create a false sentiment against the so-called "debasement of science," which it is claimed is involved in the substitution of the electric current for the guillotine or the halter.

COMPARATIVE TESTS OF LEATHER AND CANVAS-RUBBER BELTS.*

By SAMUEL WEBBER, C.E.

THE question of belting for driving the high speed dynamos in electric light and power stations, is one of considerable importance, and one on which I am often called to express an opinion.

In the first place, let me lay down as a general law, too often neglected, that the value and driving power of a belt depends upon its complete flexibility, and also on its evenness and softness of surface; which two qualities combined, permit perfect contact with, and close adhesion to, the surface of the pulleys. The next point is the weight of the belt itself, which should be as light as possible, consistent with the extreme power to be transmitted by it. This not only saves waste of power in keeping the belt itself in motion, but reduces the centrifugal action that tends to keep the belt from coming in proper contact with a small pulley at high speed. This matter, though important, is often overstated, much of the trouble often noticed being due to the rigidity and inflexibility of the belt, particularly if a double one, rather than to its centrifugal action. If anyone has ever noticed the action of one of the great cotton mill belts, at Lowell or Fall River, running at a speed of a mile a minute, on a pulley 5, 6, or 7 feet in diameter, he will remember that he has never seen much centrifugal action keeping the belt away from the pulley; but if he has seen a double belt, even at 3,000 feet per minute, run on a 12 inch pulley, he will have noticed a perceptible loss of contact.

For these reasons I would always discourage the use of a double belt, when a single one will answer the purpose on any reasonable width of pulley, or, in any case, when the pulley is less than 12 inches diameter. Belts can be run as fast as 6,000 feet per minute with perfect safety, and if flexible, will cling to the pulley, and lose nothing by centrifugal action. The consideration of weight leads me to disapprove of the so-called "link belts." Even with the latest, and I believe the best of these belts, the "Acme" belt of the Page Belting Company, of Concord, N.H., the weight of the belt is given me as 4 lbs. 4 ozs. per square foot, of which 3 lbs. 3 ozs. is leather, and 1 lb. 1 oz. iron.

Now, a first-class single leather belt, $\frac{3}{16}$ths inch thick, weighs just about 1 lb. per square foot, and I believe that an equal weight of leather, in its normal and natural condition, will transmit more power, with less loss, than if chopped up into scraps and bolted together again, in any way whatsoever.

The cost of leather has led to very many experiments to provide an economical substitute, and the first one of these to notice is the "rubber belt," or, in other words, a belt composed of several folds of canvas, covered and cemented together with a solution of India-rubber. For work in dye-houses and bleacheries this has proved very valuable; but it is soon destroyed by heat and dust, and I am not aware that it has been successfully used as yet for electrical purposes; in fact, with one exception, the cotton-leather belt, of which I shall speak later, I do not yet know of anything to contradict the old saw, "There's nothing like leather."

I give herewith the results of a series of experiments made by me at the factory of the Underwood Belting Company, Tolland, Conn., to test the comparative driving capacity of various entirely new belts.

The first test I will note was of an entirely new Hoyt belt, one of the best known on the market. This had been in stock some time, but was tested as it was for the sake of information.

This belt was 12 inches wide, $\frac{1}{4}$-inch thick, 31 feet long, and weighed $34\frac{1}{4}$ pounds. With a tension of $43\frac{1}{2}$ lbs. it drove 7 H.P. (at 754 feet per minute) and then slipped off from stiffness and lack of sufficient tension. The strain was then increased to $62\frac{1}{2}$ lbs. per foot, and the belt shortened, in doing so, $4\frac{1}{2}$ inches. It now carried 7·77 H.P. at 697 feet per minute, and with a load of 11·64 H.P. slipped $10\frac{1}{2}$ per cent., and slipped off when the load was increased.

The strain was then increased to $83\frac{1}{3}$rd lbs. per inch, which shortened it $2\frac{1}{2}$ inches more, and it now carried 8·88 H.P. at 697 feet per minute without slip. As more load was added it began to slip, increasing until with a load of 14·77 H.P. at 660 feet per minute it slipped 13 per cent., and with increased load slipped off. The belt was then reversed, bringing the softer flesh side to the pulley, the hair side having been previously used. It now carried 16·85 H.P. at 662 feet per minute, and then "jumped the pulley" suddenly with increased load, without having shown any perceptible slip previously. This test showed that on the polished iron pulley the soft flesh side *held* better than the harder *grain*.

A pair of Dodge's wooden pulleys were now put on, and the belt replaced, with the hair side to the pulley. We now got 15·29 H.P. without slip, at 739 feet per minute, but additional load caused a slip which increased with the load, so that little more power was shown, and the the test was stopped at 15·80 H.P. with the belt still on the pulleys, showing a horse-power for each inch of width at 562 feet per minute.

The next test was to cut the belt down to $8\frac{1}{2}$ inches wide, which gave an apparent strain of 117·6 lbs. per inch, as it was simply relaced in the old holes. This, on the wooden pulleys, gave 10·19 H.P. without slip at 711 feet per minute, and 11·79 H.P. with a slip of 3·77 per cent., at 699 lbs., and then went off with increased load.

A pair of paper pulleys from Westinghouse, Church, Kerr & Co., were then substituted and the belt replaced as in the last trial. It now gave on these pulleys 15·69 H.P. without slip, at 704 feet per minute, or at the rate of 1 H.P. per inch, for 374 feet velocity. This finished the trials of this belt, which came out as good as new, and had not stretched an inch when we got through with it.

* *Electrical World.*

We will now compare this with a series of tests of a very soft and flexible belt, known as the "Schultz Rawhide Belt," under the same conditions.

This belt, 31 feet long, 12 inches wide, and $\frac{3}{16}$ths inch thick, weighed 29 lbs.

It was first tried, as before, with a strain of 43 lbs. per inch on iron pulleys, grain side to the pulley. This likewise proved to be an insufficient strain, and after giving 6 H.P. without slip, and 9·48 H.P. with a slip of 8·43 per cent., at 725 feet per minute, it went off the pulley with increased load. With the increase of strain to 62½ lbs. per inch it gave 11·10 H.P. at 697 feet per minute, and 16·27 H.P. with 5·66 per cent. slip at 675 feet per minute, slipping off with increased load.

With a strain of 83⅓rd lbs. per inch we got 15·79 without slip at 667 feet per minute, and 19 H.P. with 5·66 per cent. slip at same speed, going off with increased load. This showed 421 feet per minute per horse-power per inch.

We then put on the wooden pulleys, relacing the belt in the old holes, and got 19·80 H.P. without slip at 691 feet per minute, and 26·16 H.P. with a slip of 3 per cent. at 705 feet per minute. With an additional load we got 26·87 at 693 feet per minute with a slip of 4·59 per cent., and with more load "stalled the engine."

This last test showed 309 feet per minute per horse power for each inch of width, and fairly illustrates the difference between a stiff and a flexible belt.

We, however, split this belt down as we had the other one to 8½ inches wide and repeated on the wooden pulleys. Lacing in the old holes, we now got the strain of 117·6 lbs. per inch, which proved too much for the belt, for although we now got 22 H.P., at 691 feet per minute, *without slip*, or at a speed of 261 feet per minute for each inch of width, the belt "jumped the pulleys" with the next increase of load, and when we tried it on the paper pulleys we only got 16·46 H.P. without slip, at 739 feet per minute. The belt slipped off with the next increased load, and on applying the scales we found that the tension had fallen to 77·7 lbs. per inch, and on taking it off we found it permanently stretched 1¾ inches. We were perfectly aware all the time that we were overloading the belt, but our object was to find how much it would stand.

These experiments confirm the already well established fact that a leather belt will safely bear a strain of 350 lbs. per square inch of area, or 87½ lbs. per inch of width for a belt ¼th inch thick, or 66 lbs. for one of $\frac{3}{16}$ths inch, or an ordinary single belt, and that the latter in good condition, soft and flexible, will easily convey 1 horse-power for each inch of width at 600 feet per minute. They also show very plainly the difference in the hold on the pulley of rigid and flexible belts, and this difference would increase with the velocity on small pulleys, as both the centrifugal force and the entrainment of air would be greater. An ingenious perforated belt for high speed has been introduced lately by Messrs. Chas. A. Schieren & Co., of New York, which I have not seen in operation, but of which the samples impress me favourably. The slight longitudinal perforations are not sufficient to materially weaken the belt, while at the same time they afford an easy passage for entrained air.

I may be thought severe on "link-belts," but my opposition to them is based on sound mechanical principles, for high speed, and if a great power at low speed is required. When shafts and gears are impracticable I should use a metallic link or chain on "sprocket pulleys," rather than trust to friction. With these remarks I will leave the subject of "leather," and turn to my notes on canvas belts of different kinds. The series of experiments to which I have referred shows a test of a simple canvas or duck belt without any preparation. This belt, 31 feet long, 12 inches wide, $\frac{3}{16}$ths inch thick, weighed 21½ lbs. It stretched 13¼ inches, with a strain of 43⅓rd lbs. per inch, gave 4·86 H.P. without slip at 754 feet per minute, slipped 3·83 per cent. with 5 H.P., and slipped off with increased load.

When saturated with size, under a strain of 83⅓rd lbs. per inch, it carried 5·75 H.P. without slip, at 739 feet per minute, then began to slip as the load was increased, until it went off after giving 10·35 H.P. with 9 per cent. slip.

Next came a "Main" or "Gandy belt," 31 feet long, 12 inches wide, and $\frac{33}{16}$ths thick, weighed 41½ lbs. It was composed of heavy cotton cloth, folded and stitched, and saturated with oil and red paint. It stretched 13¼ inches before lacing with the strain of 43⅓rd lbs. per inch. It carried 7·20 H.P. without slip at 764 feet per minute; with 8·43 H.P. it slipped 8½ per cent., and went off with increased load. With a strain of 62½ lbs. per inch, it stretched 2 inches more, and drove 8·08 H.P., without slip, at 725 feet per minute, slipped 8·70 per cent. with 9·48 H.P., and then slipped off. With 83⅓rd lbs. per inch, it stretched 3 inches more, and carried 10·48 H.P. without slip at 732 feet per minute. With 14·22 H.P., it slipped 10 per cent., and then went off.

Next comes a four-ply duck belt, weighing just 1 lb. per foot, and saturated with linseed oil and plumbago. This stretched 7¾ inches with 43⅓rd lbs. per inch, and drove only 2·40 H.P. without slip, it having been dusted with powdered soapstone, to keep it from sticking together in the fold. The soapstone got rid of, and the strain increassd to 62½ lbs. per inch, it carried 13·27 H.P. without slip, and went off with an increase of load. At 83⅓rd lbs. per inch, it carried 16·65 H.P. without slip at 697 feet per minute, but slipped 5·71 per cent. with 17·28 H.P., and then off.

A first-class rubber belt of same dimensions, weighing 37 lbs., showed *no slip* in any test until it finally *jumped* the pulleys, giving 8·07 H.P. at 725 feet per minute, with 43⅓rd lbs. strain; 13·68 H.P. at 660 feet per minute, with 62½ lbs. strain, and 18·61 H.P. at 650 feet per minute, with 83⅓rd lbs. strain, the last test starting the rubber covering. The variations in speed are due to the incapacity of the engine to carry these loads in addition to its regular work.

We now come to the cotton duck leather-lined belt already mentioned. This belt was a four-ply duck, with a soft leather lining cemented on, and weighed 37¼ lbs., of the same size as the others, but was ¼-inch thick, or $\frac{3}{16}$th inch duck and $\frac{1}{16}$th leather. It stretched 2⅓ inches with 43⅓rd lbs., and drove 10·80 H.P. without slip at 754 feet. With 12·4 H.P. it slipped 13 per cent., and then slipped off. With 62½ lbs. per inch strain it carried 11·88 H.P. without slip at 747 feet per minute, stretching 2¼ inches.

It carried 19·40 H.P., with 14·7 per cent. slip at 711 feet, and then slowed down the engine without going off. With the steam increased to 83⅓rd lbs., it carried 16·98 H.P. without slip at 711 feet per minute, and with 21 H.P. and 9 per cent. slip slowed down the engine to 690 feet, and the test was stopped with the belt still on. All these last tests were on iron pulleys. We now changed to the wooden ones, and got 27·87 H.P. without slip, stopping the engine.

We then split the belt down to 8½ inches, or 117 lbs. per inch, and on the same pulleys got 25½ H.P., with 1 per cent. slip. Changing to paper pulleys, we got 25·30 H.P. *without* slip, but exhausted our power as before, and on applying the scales found the belt to still hold its strain of 1,000 lbs. As will be seen from the above tests, we could not get higher speed with these belts, so we took a five-ply belt of same kind, 5 inches wide, $\frac{5}{16}$ths inch thick, 31 feet 2 inches long, weighing 19 lbs. This stretched 2¼ inches under a strain of 77 lbs. per inch, and gave 7·20 H.P. on iron pulleys without slip at 754 feet per minute. With 9·80 H.P. it slipped 3½ feet, and with increased load slipped off. On wooden pulleys it drove 10·19 H.P. without slip at 711 feet per minute, or at the rate of 348 feet of belt per minute for a horse-power to each inch. We then put back the iron pulleys and increased the strain to 117 lbs. per inch, and got 10·29 H.P. without slip at 718 feet, and 12·63 H.P. at 698 feet, with 5·65 per cent. slip. We then put on a larger pulley to increase the speed, and under the same strain got 18·62 H.P. without slip at 1,301 feet per minute, and

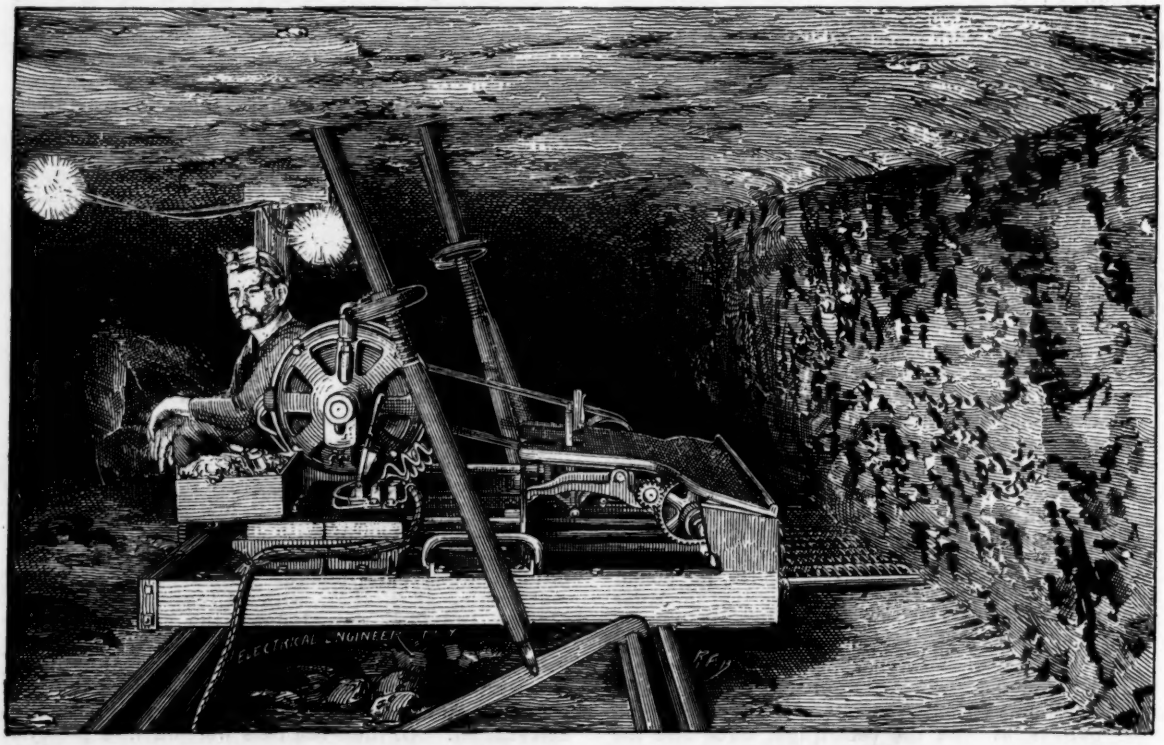
24 H.P. with 1·50 per cent. slip at 1,276 feet, 24·59 H.P. with 3·10 per cent. slip, and 24 H.P. with 5·50 per cent. slip at 1,222 feet per minute, slowing down the engine so that we could not continue the tests. These last two tests, however, go to prove that the slip does not increase with the velocity, and the last three were all stopped in good order, with the belts still on the pulleys. I think they go to prove that a strong light-woven belt, with a leather lining, if the cement is perfect, will be the belt of the future for all magneto-electric machines, as they combine great strength with light weight and great clinging properties.

I do not propose to enter into any discussion which may involve patent rights, but will simply say that while these cotton-leather belts tested were made by the Underwood Manufacturing Company, a very promising belt of the same materials is also made by the Page Belting Company, of Concord, N.H., differing in construction thus: Two canvas belts are used, meeting in the centre, with a single leather lining, which acts as a hinge, and permits the belt to adapt itself closely to a *coned* pulley.

that no metallic part is exposed. All wood work of the switches is made thoroughly waterproof and the switch handle is detachable and carried by the motor man. This prevents the switch being tampered with by meddlesome persons.

The wire used in these mines is all of the Clark rubber-covered special mine finish type, and all wire connections are made with McIntire connectors. All wood work is made waterproof with P. & B. compound. The coal cutting motors in the rooms are connected to the main line by a specially made insulated flexible cable, which can be coiled on a special reel and taken to another room in a few minutes. This cable when in use is supported by glass hook insulators made for this purpose.

Six "Hercules" coal mining machines, with 3 H.P. Tesla motors mounted thereon, as shown in the engraving, are now in operation in these mines. The machine and motor complete weighs about 1,000 pounds and is easily handled and shifted from room to room by one man. A specially designed truck is used in conveying machine from one room to another.



TESLA MOTOR DRIVING HERCULES COAL MINING MACHINE.

AN ELECTRIC COAL MINING EQUIPMENT.

A HIGHLY interesting electric plant was recently put in operation in the First Pool Monongahela Gas Coal Co.'s mines at Willock Station, Pa. This electric equipment was designed and installed by the Mill and Mine Electric Equipment Co., of Pittsburgh, Pa., under the supervision of Mr. W. A. Giles, general manager and electrical engineer for the company, who has supplied the following interesting particulars regarding the plant to the New York *Electrical Engineer*.

The power plant consists of two 12 × 20 Carter engines and one 30 H.P. 3-wire, 4-pole Westinghouse self-exciting, alternating generator. All switches, meters, &c., are mounted on a switchboard in a most convenient location to be easily handled. The voltage on the main line is about 300 volts. Inserted in the main line at convenient locations are several specially designed mine switches with safety catch attachments, and all switches used in these mines are so designed

These machines, by means of a set of gang bits or augers, make an undercut 3 inches high, 36 inches wide by 42 inches deep. One man with this machine will average 40 cuts, or about 43 tons of clean cut coal in 10 hours. This is equal to the product of 12 to 14 pick miners.

The ventilating outfit in this mine consists of a 12 feet Pollock fan, with a capacity of 30,000 cubic feet per minute. It is situated at the bottom of a shaft 75 feet deep, and is so arranged that the fan can be changed from an exhaust to a blower in five minutes. This fan is also run with a 3 H.P. Tesla motor.

The pumping outfit consists of a centrifugal pump of a capacity of 90 gallons per minute, mounted on the same truck with 3 H.P. Tesla motor and connected to the same by means of a belt. This pump and motor can be taken to any part of mine and connected to the power line in a few minutes.

These mines have an incandescent electric light plant, consisting of a United States 300 volt, automatic incandescent dynamo, running 150 Sawyer-Man lamps,

mounted in special waterproof mine sockets with rubber insulating joints. These lamps are connected in loops of three in series across the main circuit, and placed along the main entry at a distance of 80 to 90 feet, and three 16-C.P. lamps are placed in each room. This gives perfectly satisfactory illumination and demonstrates the great importance of better light in coal mines.

The following record shows the large amount of work which can be accomplished with but a few machines. Indeed it has been demonstrated that they can work faster than the rooms can be cleaned up of the coal which is brought down. The record, which is taken from the company's books, extends from July 1st to August 8th, and each cut represents about $1\frac{1}{10}$ ton of nut coal.

	No. of machines at work.	No. of cuts made.	No. of machine-hours run.
July 1	5	113	35½
„ 2	4	119	34½
„ 3	4	107	29
„ 7	4	117	32½
„ 8	4	109	31
„ 9	4	140	37
„ 10	4	127	34½
„ 11	4	134	35½
„ 12	4	135	35½
„ 14	4	130	35
„ 15	4	134	36½
„ 16	4	134	36
„ 17	4	140	38
„ 18	3	55	14
„ 19	3	31	8
„ 21	3	69	17
„ 22	4	80	20½
„ 23	4	101	29
„ 24	4	134	36
„ 25	4	69	19
„ 26	3	45	12½
„ 28	4	124	35½
„ 29	4	103	28½
„ 30	4	75	21
„ 31	3	55	16½
Aug. 1	4	118	30½
„ 2	4	124	33½
„ 5	4	116	35½
„ 6	4	127	34
„ 7	4	141	36
„ 8	4	130	38

The Mill and Mine Electric Equipment Company is now putting a similar equipment in Mr. Frank Armstrong's Summer Hill Mines at Woodville, Pa.

OUR OCEAN TELEGRAPH MONOPOLIES.

THE *Economist* in its issue of the 23rd ult. has an interesting article, under the above heading, which is as follows :—"We have received a copy of a petition to the Queen on behalf of the British merchants, bankers, shipowners and others carrying on business in Hongkong, China, and Japan, praying that steps may be taken to set aside a secret convention between the Eastern Extension and Great Northern Telegraph Companies and the Chinese Government, whereby it is understood that a rate of $2 per word shall continue to be charged, even after the Chinese land lines have effected a junction with the Russian, upon all messages to Europe west of Russia itself. It is argued that thereby a monopoly hurtful to British interests in the East will be maintained, and that Russian merchants will be placed in an exceptional position of favouritism by contrast with the rest of Europe. We are quite aware that the Eastern and Eastern Extension Companies, by agreement with the Great Northern, the Indo-European, and other companies, have taken all precautions available to secure their monopoly and avoid the cutting down of rates. We do not raise an objection to such combination ; this is an age of combination. But we must be permitted to welcome counter-combinations. The agitation which has ended in an agreement for the reduction of the Australasian cable rates would scarcely have succeeded* had the Pender companies not desired to take the wind out of the sails of the proposed Pacific cable, which was favoured by Canada, by Queensland, in some degree by New Zealand, and, after a reserved fashion, by the Home Government. When that reduction comes into force, the China and Japan rates will be the highest in the East, and naturally the China merchants feel themselves aggrieved. On the other hand, the cable companies argue that they established the system when the Eastern merchants were only too glad to welcome them on any terms ; that they obtained rights which must not be ignored, and that after 20 years the Eastern Company is only paying 6½ per cent. upon its ordinary shares, and the Eastern Extension only 7 per cent. Neither the Australasian nor the China merchants, they say, have a right to depreciate their property. Rates, in fact, would remain without alteration indefinitely were it not for agitation backed up by prospects of competition ; and the companies, as we have said, strive, by all means in their power, to defer that evil day by repressing competitors whenever they show signs of presenting themselves.

"It is worth while, however, examining into the claims which the various cable companies put forth to an adequate remuneration on their invested capital. Six and a-half and seven per cent., though very fair rates as times go, are nothing extraordinary in themselves upon investments of twenty years' standing. But it must be remembered that these are the rates payable on a watered capital, and that they represent considerably higher returns upon the money actually put into the cables. It is now seventeen or eighteen years since the seven companies connecting this country with the East were amalgamated into two ; and those amalgamations were effected in the following manner :—

	Share capital.	Converted at per cent.	Capital after conversion.
Anglo-Mediterranean	£430,000	200	Eastern Telegraph Co.
Falmouth and Malta...	760,000	120	
Marseilles, Algiers, and Malta	200,000	100	
British Indian	1,187,500	120	
	£2,577,500		£3,397,000
British Australian	540,000	110	Eastern Extension Co.
British Indian Extension... ...	460,000	150	
China Submarine	525,000	110	
	£1,525,000		£1,997,500

"Thus, the Eastern capital was watered to the amount of £819,500, and the Eastern Extension to the amount of £472,500, and a dividend of 6½ per cent. on the Eastern capital should be read as over 8½ per cent. on the original capital, while 7 per cent. on the present Extension capital means over 9 per cent. on the capital prior to its being watered. Beyond this, these companies have worked themselves into a very strong position by not dividing to the full extent profits legitimately earned. When the Eastern Company was compounded in 1872 out of the four lines already referred to, their combined reserves only reached £70,000, whereas at the present time the reserve is £600,000, while extensive additions to the system have been effected out of revenue. We do not say that this conservative policy has not been a wise one. Far from it, we consider that the best interests of the proprietors have been consulted. But the dividends paid have been no guide to the profits made, and if requisite, the tariffs could be much reduced without affecting the payments to the shareholders. The Eastern Extension Company have even larger reserves, reaching to as much as £700,000, and this company has likewise made large additions to the cables out of revenue.

"We have, so far, dealt only with the Eastern companies. But it is worthy of remark that the 'stock-watering' in the instances of the Atlantic cable companies was carried to still greater lengths. Not to

* It will be remembered that the proposed agreement has fallen to the ground.

go back to the original amalgamation of the Anglo-American and Atlantic Telegraph Companies, there was the amalgamation of 1873, when the following additions were made to the capital invested :—

	Original Capital. £		Anglo-American Capital. £
Anglo-American	1,675,000	.....	2,548,450
French Atlantic.....	1,650,000	.....	3,451,550
Newfoundland	864,520	.....	1,000,000
	4,189,520	.....	7,000,000

"Anglo-American stock now stands at about 50 per cent. discount, but we do not consider this to represent any discount upon the original investment; and we believe that as regards the old Anglo-American capital as it stood prior to 1868, it represents a substantial premium. But without seeking to make too much of those waterings, which occurred sufficiently long ago to have been almost forgotten, it may be pointed out that reductions in tariff are not the loss to the companies that Sir John Pender would argue. In 1868 the Atlantic Company was charging £5 5s. for 20 words, or, say, 5s. 3d. per word on a long message, whereas nowadays 1s. per word brings a far greater revenue. Only, the Anglo-American Company now obtain considerably less than one-half the Atlantic traffic, whereas years ago they had a monopoly such as Sir John Pender rules over now. Fair reductions of tariff are sure in a year or two to bring their own recompense, and if the Eastern Extension and Great Northern Companies seek to disarm opposition and competition, they must be alive to meeting the requirements of modern business."

REVIEWS.

Leçons sur L'Electricité professées à l'Institut Electro-Technique Montefiore annexé à l'Université de Liége. Par ERIC GERARD. Tome II. Canalisation et Distribution de l'énergie électrique; Applications de l'Electricité à la production et à la transmission de la puissance motrice à la Traction, à l'Eclairage et à la Metallurgie. Paris: Gauthier-Villars et Fils, 55, Quai des Grands-Augustins.

We decidedly like this second volume better than the first, as there is more originality in its composition and the information given is very fairly up to date, a point of great importance, seeing the rapid changes which are continually taking place in the science. The author again gives very general information, describing systems employed by various countries, and methods, apparatus, &c., devised by inventors of every nationality. In referring to overhead wires, he gives in full the Board of Trade regulations with regard to the same. Theory is not entered into largely, but when it is considered necessary it is judiciously curtailed. Altogether the writer has done his self-imposed work with great discretion, and has produced a volume which should prove of great use to the pupils of the Institute of which he is director, and to others.

Illustrated Catalogue and Formulæ. CROMPTON AND COMPANY, LIMITED, Chelmsford and London.

This is an excellent little pocket-book, and although, of course, it is actually issued for advertisement purposes, it is a book which should prove useful to everyone who has anything to do with electric lighting, as it enables estimates, &c., to be drawn up with great facility. It is well worth the one shilling charged for it.

Thunderstorms to Order.—A Chicago electrical trading company professes to be able to supply anything in the way of electricity from a push-button to a thunderstorm.

NOTES.

Lighting a Flour Mill.—Messrs. Ernest Scott & Co., electrical engineers, Newcastle-on-Tyne, have obtained the contract for the complete electric light installation for the new flour mill at Dunston, being built by the Co-operative Wholesale Society. This mill when completed will be one of the largest in the kingdom, if not the largest, and the electric light plant which is being put in in duplicate will consist of two 400-light "Tyne" compound-wound dynamos running at 600 revolutions per minute, and 466 16-C.P. incandescent lamps. The arc light installation will consist of one 9-unit "Tyne" compound-wound dynamo and 10 ampère "Tyne" arc lamps in strong water-tight lanterns with reflectors. We hear that Messrs. Ernest Scott & Co. have a considerable quantity of work in hand of all descriptions, including a large contract for the lighting of Messrs. Arthur & Co.'s works in Glasgow, in which two 400-light "Tyne" dynamos will be used. They are also lighting Messrs. John Bright & Bros.' Mills at Rochdale, the new works of the *Bolton Evening News*, and the cold meat rooms of the Northern Counties Ice Company.

Electric Lighting at Hastings.—A public meeting for the purpose of considering the electric lighting proposals of the Hastings Town Council was held last week, under the presidency of Mr. H. Chapman. The chairman ridiculed what he described as the electric light "job," and which he feared would be carried into effect unless the ratepayers spoke out. A committee was appointed to request the mayor to call a town's meeting.

Ship Lighting.—The contract for lighting four new steamers being built for the Manchester, Sheffield and Lincolnshire Railway Company has been given to Messrs. Paterson and Cooper. Two of these are in hand at Earle's shipyard, Hull, the other two at Swan and Hunter's, Newcastle. Messrs. Paterson have on hand besides the above the ss. *Innamincka*, *Tuskar*, *Arranmore*, *Garnet*, *City of Dundee*, and H.M. training ship *Empress*.

Lewes Lighting.—At a recent meeting of the Town Council an estimate for lighting the town electrically was received from the Gülcher (New) Electric Light and Power Company, Limited, based on the following lines. A complete set of plant and apparatus for 240 16-C.P. incandescent lamps will be provided. These lamps may be distributed in any manner desired over 7½ miles of streets. Incandescent lamps of a higher candle-power may be substituted where desired, the total number of lamps being in proportion to the candle-power, *i.e.*, a 32 C.P. incandescent lamp takes the place of 2 16-C.P. lamps, a 48 or 50 C.P. takes the place of 3 and so on. Modifications in the incandescent lamps of this kind will not affect the cost of the installation. Arc lamps of 2,000 C.P. nominal can be supplied to take the place of 12 16-C.P. incandescent lamps, but every such substitution will increase the total cost of the installation by £15. The company undertake to start the running within 16 weeks after date of order. The estimate does not include the supply of lamp-posts as it is presumed the present gas lamp-posts will be utilised for carrying the incandescent lamps. Since a continuous supply of current is not necessary the company feels quite confident that a single set of generating plant is all that is needed to meet the case, but for absolute security recommend the advisability of duplicating the generating plant, this course would entail a further expenditure of £500. The consideration of the matter was adjourned.

American Theatre Lighting.—The Duquesne Theatre at Pittsburg, Pa., is to be lighted throughout by electricity with something over 800 lights. Though not as large as some, it is claimed that this will be a model plant.

Electric Lighting in Germany.—The municipal councils of German towns would appear to prefer the carrying out of electric lighting schemes rather than place these in the hands of companies. Cassel is to have an installation commencing with 3,000 incandescence lamps; Breslau has voted £50,000 for an illumination to begin with 8,000 lamps, the central station being built to supply 30,000; Cologne has determined on an installation of 12,000 lamps of 16 candles; and at Dusseldorf the corporation has decided on an illumination of 20,000 incandescence lamps at a cost of £100,000.

Electric Light in Siam.—Vice-Consul Stringer, of Bangkok, states that last year a Siamese company, called the Siam Electric Light Company, was formed, two of the leading princes being secretary and treasurer respectively. An agreement was entered into between certain Siamese of high rank, of whom the present head of the Treasury is the leading spirit, and the Brush Electric Light Company, by which the latter engaged to supply engineers and material for the establishment of a system of electric lighting in the city within a radius of four miles from the central station in Bangkok. There being no supply of gas, except on the road in front of the Royal Palace, and the thoroughfares being but dimly lighted with oil lamps, the employment of electricity will no doubt place Bangkok in a position superior to that of most Oriental towns. The owners of large rice and saw mills also, many of whom keep their works going day and night, will find the light a great convenience. The shares of the company are now quoted at a premium.

Electricity for Spectacular Effects.—A dynamo and a complete electrical plant will be carried by "The Limited Mail" theatrical company, to produce the telegraph and other effects in that play.

The Electric Light at Godalming.—This, it will be remembered, was the first town in the United Kingdom to adopt electricity for public lighting. The installation was not a success, and recourse was had again to gas. Now, with a view of giving electric lighting another trial the members of the Town Council are going to visit Bath and inspect the installation there.

The New York Phonograph Company.—The various branch phonograph companies of New York have been combined in one corporation, named the New York Phonograph Company, the President of which is J. P. Haines.

Woodhouse and Rawson United, Limited v. Appleton, Burbey and Williamson.—A cricket match, between elevens representing the above firms, was played on Saturday last, at Raynes Park, which, after a very exciting game, ended in a victory for the former by one run.

Interruptions and Repairs to Submarine Cables and Land Lines:—

Section.	Interrupted.	Repaired.
Cable Hongkong—Foochow ...	21 July, 1890,	26 July, 1890.
„ Suakim—Perim	9 May „	29 „ „
„ Banjoewangie—Roebuck Bay,	11 July „	2 Aug. „
„ Para—Maranham	24 „ „	21 „ „
Land Line Moulmein—Bangkok	28 „ „	30 July „
„ „ Saigon—Bangkok ...	9 Aug. „	10 Aug. „
„ „ „ „ ...	13 „ „	14 „ „
„ „ „ „ ...	21 „ „	22 „ „

Electrical Nomenclature.—In a communication which appears in *Industries* of August 29th, Mr. James Swinburne criticises the proposal made by Prof. J. A. Fleming of using the word "hen" (derived from the name of Henry) as the unit of self-induction. The article is but a short one, yet in it there is space to discuss such terms as secohom, parasangs, gilb, gil, lig, dun, nud, scot, frank, cavs, vacs, &c. If this sort of terminology is continued much further, the electrical engineer of say a decade hence will be obliged to carry about with him a technological dictionary.

Accumulators in Telegraphy.—Accumulators have been employed to a considerable extent in the central telegraph station at Berlin since the month of October, 1888. The administration set up 25 batteries of Tudor accumulators. The current is distributed in three directions and serves 68 lines, on which 41 Morse and 27 Hughes instruments are worked. The three systems comprise one of 36 wires at 34 volts, another of 12 wires at 40 volts, and the third of six wires at 60 volts, with one wire at 80 volts. The installation has proved so successful that a fourth system is in course of being supplied with current in the same manner. The batteries are capable of working for one month, but are generally recharged every 10 days by means of a Siemens dynamo worked by a gas motor of 8 H.P.

Telephone Wire.—It is reported that the French Administration of Posts and Telegraphs has decided to replace the phosphor bronze wires on telephone lines, and the iron wires on telegraph lines, with "Martin" wire, the results of very thorough experiments having conclusively proved the great superiority of the latter. This wire consists of a steel core covered with soft copper.

The "Peral."—The following paragraph appears in *Industries* of August 29th:—"The Government will soon publish the official report of the Naval Commissioners appointed to report on the trials of the submarine vessel *Peral*, lately made in Cadiz Bay. It seems that the report, though drawn up in very flattering terms for Lieutenant Peral, nevertheless recommends the Government not to construct any vessel of this class, as the trials have proved that the vessel is unseaworthy, and that it does not offer the conditions required for submarine navigation, even on coasts and in fine weather."

Cost of Accumulator Traction.—The Société Française d'Accumulateurs Electriques have issued an estimate as to the cost of accumulator traction on their system. A line equipped with 40 cars would cost £40,000, including the whole of the plant at the generating station, but excluding the cost of the station building. Out of these 40 cars, four would be kept as reserve, and with 36 cars in daily service, they estimate the cost at ·28 francs per car kilometre, or 4½d. per car mile. This figure includes the cost of maintaining the rolling stock (including depreciation of batteries) and fixed machinery, and the working expenses at the charging station. Each car would travel 74 miles daily. The actual results, however, on the Barking line, prove that enough has not been allowed for maintenance of batteries.

Personal.—We hear that Mr. Arthur C. Cockburn has now ceased to be connected with the Acme Electric Works, his future address being 22, Streatley Road, Brondesbury, N.W., where he will continue to practice as a consulting electrical engineer.

A Chance for Inventors.—A New South Wales correspondent to a New York electrical paper complains that there has not yet been introduced a really successful electric sheep-shearing machine. The want of one is badly felt in Australia.

Electric Traction in Germany.—The Berlin *Tageblatt* says that the question of electric railways is about to be taken up seriously in Germany.

Siamese Telegraphs and Telephones.—The Siamese telegraph service has lately been considerably improved. The department is under the control of a Siamese prince, and most of the *employés* are either German or French. New telegraph stations have been established at Rathburi, Petchaburi, and Bangtaphan. A system of telephones has been laid down in Bangkok, with connections and exchanges on both sides of the river. All the large firms and trading houses, and many private individuals, are subscribers.

Music by Telephone.—An experiment made in Berlin, on Tuesday, in transmitting opera music from the Opera House to the Urania Theatre of Science by means of a telephone was a complete success. It is hoped that it will be possible to make an arrangement with the telephone exchanges to furnish other places with music through the telephone.

Gas by the Pennyworth.—The Gas and Lighting Committee of the Bolton Corporation have just decided to make an experiment with a new kind of meter, strongly advocated by one or two of the labour representatives for the automatic supply of gas. In some quarters there is a strong aversion to quarterly gas accounts, and the result is that oil is used instead of gas, and to overcome this the Gas Committee have fitted in a few houses a meter which supplies gas on the same principle as the automatic sweetmeat machines—by placing a penny in a slot.

The Telephone at Sea.—The telephone has played an important part in the naval manœuvres of the Swedish fleet. There is a telephonic post on board each vessel, and when lying at anchor they can telephone to one another by means of insulated conductors, which are run down the anchor chains and submerged. In Sweden, trading vessels arriving in dock are quickly connected by telephone to the nearest exchange.

The Tory Island Cable.—It has transpired that the opening of the Tory Island cable on Tuesday almost resulted in a fiasco, and the telegram to the Queen was very nearly not being sent at all. Previous to the ceremony, it was found that no communication could be had with the mainland from Tory Island, and on investigation it was discovered that the cable running over the Horehead Bridge was broken. The broken ends of the cable were found lying in the stream, and the connection was established just in time.

Microphonic Phenomena.—The series of papers which we have recently published, from the pen of Mr. A. M. Tanner, will, we feel sure, be much appreciated by experimentalists, and his contribution on page 279 will specially appeal to the sympathetic interest of Prof. Hughes. Mr. Tanner has done good service in unearthing the researches of men now forgotten.

The Annealing of Copper.—The paper by Mr. Cummins, which we print on another page, demands the attention of all manufacturers of copper.

Gas versus Electric Light.—We wonder what complexion the gas journals will put upon the results which M. Paul Hoho describes on page 260? Is it possible that the author may have based his conclusions on false premises; if so, we shall soon see them opposed by our contemporaries.

Fatal Electrical Accidents.—New York, August 30th.—A fatal accident, due to electricity, occurred to-day at Wheeling, West Virginia. Two men stepped upon a wire connected with a powerful dynamo, and fell dead. People ran to raise them, and two who were lifting the bodies from off the wire sustained severe electric shocks.

Cincinnati, August 30th.—A fatal electric light accident occurred here to-day. A lineman employed by the electric light company of this city inadvertently grasped a live wire, and was instantly killed. It was found that the unfortunate man's hand had been almost burnt off.

It seems from these telegrams that although electrical execution is said by the opponents of the measure to be quite unreliable, the number of inadvertent fatalities in the States show no signs of diminution.

Companies Meetings.—We desire to call attention to the report of the Brush Electrical Engineering Company, Limited. So far as one can judge, the conclusion of the directors seems to be well founded.

The Telegraphists' Grievance in Dundee.—Dundee telegraphists have passed resolutions condemning the new order stopping the increase granted to some of the classes until next year, and calling upon those who had participated in the increase to return all the money received.

Belting.—To all users of motive power, Mr. Webber's article on belting will be welcome, and perhaps it may be the means of bringing forth the experiences of belt users on this side of the water. Mr. Webber knows of but one exception to the old adage, "There's nothing like leather."

New Arc Lamps.—The Sperry Electric Company of Chicago has been granted a patent for an improvement in a single arc lamp, a simple adjustment which at once changes the lamp from an eight to a 16-hour one. The device can be applied to any arc lamp known on the market. This is, we imagine, the outcome of the litigation on double carbon lamps.

Gas Explosion.—An explosion of gas occurred on Monday evening last on the premises of Mr. J. W. Tacon, 277, High Holborn. The force of the explosion was of sufficient violence as to partially destroy the shop front, and damage the interior of the establishment, but happily the assistants and others in the place at the time escaped without injury. Mr. Tacon is only removed one door from an electrically lighted shop, having probably the oldest installation of any importance in the metropolis.

The Late Cable Interruption.—"The manager of the Telegraph Department informs us that the recent cable interruptions were caused by a very severe earthquake. The duplicate cable, which was repaired yesterday morning, was broken in three places within 65 miles of Banjoewangie. The other two cables are not yet repaired. The following telegram from the general manager of the Eastern Extension Company at Singapore has been received by Mr. W. Warren, the manager of the company in Australasia :—'In restoring duplicate cable Baly Straits ships found for a distance of 30 miles cable much broken and overlaid from effects of disturbances at bottom of ocean. Ship now at work on original Darwin-Java cable.'" The above extract from the Melbourne *Argus* of July 22nd, 1890, recently to hand, throws a little more light on the simultaneous interruption of the three cables to Australia. From this it appears that the cables were not only ultimately interrupted, but that the first cable repaired was found to be broken in three places; in fact, to quote from the leading article of the same paper on this subject :—"There is now unchallengeable evidence that the company made a serious mistake in running all its cables to Australia from one place, and that the fancied security in which we imagined ourselves to be reposing could only continue so long as an earthquake did not happen near the converging point. We have learned now that it is unwise to put trust in any single means of communication with Europe, and to all intents and purposes the Eastern Company's service is a single service, though the traffic, when all lines are working may be distributed over three routes. The connection at Banjoewangie represents the weakest link and governs the strength of the entire chain. Our interests demand that we must not be deprived of the means of swift correspondence even for a day, and it follows that the service which makes such an interruption possible is ill-suited to our requirements."

Nalder Brothers and Company.—The premises in Westminster that have been occupied during the last few years by Messrs. Nalder Bros. & Co. being now found insufficient for their rapidly expanding business, the firm has been obliged to take new works at 16, Red Lion Street, Clerkenwell. These are to be ready by November, and as they will be well equipped with new machinery, improved facilities will be afforded for turning out electrical work of all kinds.

Contracts by Telephone.—At the present day the telephone plays an important part in commercial affairs, and most mercantile men find it a great convenience in facilitating and accelerating business. But a recent American lawsuit goes to show that, handy as the telephone may be to business men, the convenience that it affords is not without its drawback. The case to which we—the *Machinery Market*—allude is this:—In an action brought in the United States Courts by the Paddock-Hawley Iron Company against Messrs. Pullis Brothers, it appeared that some iron was ordered by telephone, but that, when the bill was sent in, Messrs. Pullis Brothers demanded a reduction of some 10 per cent., in virtue of an agreement to that effect, which they said had been made by telephone. In reply to this, the plaintiffs asserted that there were only two members of their firm empowered to make such contracts, and that neither of them had heard of this telephonic communication until after this controversy had arisen. The Court held that, while a telephonic contract was as binding as any other, the same rule of evidence applied, and as there was not sufficient evidence to disprove the assertion of the plaintiffs, it was decided that the bill must be paid in full. This appears to be an equitable decision, founded on common sense, and simply serves to point the old moral, that all contracts should be reduced to writing. It is obviously as impossible to bring a telephonic contract into court as any other verbal one.

Correction.—In our last issue we referred in our "Official Returns of Electrical Companies" to the business carried on by Messrs. Head, Wrightson and Company, Limited, at South Shields; it should read, "at Stockton-on-Tees."

Dissolution of Partnership.—The firm of W. Mackie and Chalmers, electrical engineers, Turk's Head Yard, Turnmill Street, Clerkenwell, has been dissolved by mutual consent, as and from November 30th, 1889. All debts due to and owing by the firm will be received and paid by Matthew William Walbank Mackie.

Experimental Electric Lights.—The exhibition of experimental electric lights from points visible in the Needles Channel will be resumed at intervals during the present month.

Electric Lighting at Portsmouth.—At Tuesday's meeting of the Portsmouth Town Council, a special committee was appointed to prepare a report as to the best mode of adopting the Electric Lighting Acts. The palatial new Town Hall is already lighted by electricity, and it is known that a strong opinion exists among many of the members of the Corporation that the time has arrived when the municipality should offer to supply the electric light to the inhabitants. On the other hand, considerable opposition is certain to be offered to any such scheme, as the gas interest is somewhat strongly represented in the Portsmouth Town Council.

University College, Bristol.—The calendar for the ensuing session, commencing 1st October, is now published. The course of electrical engineering covers three sessions and includes training in electro-technics, mathematics, physics and chemistry, with continuous laboratory work and practice in testing. It is recommended that, inasmuch as an electrical engineer must, in addition to his knowledge of electricity, have a thorough acquaintance with practical engineering, all students who enter for this branch should arrange with some firm either of electrical or of mechanical engineers for a course of training in engineering work. The college authorities have lately arranged for students to spend one or two terms of six months in works during their college career.

Edinburgh International Exhibition Notes.—A correspondent sends us the following clippings:—A trip to Slateford in one of the electric launches was then undertaken, and this gave unfeigned pleasure to everybody. For a wonder it wasn't raining, and the atmosphere was clear enough to afford a glimpse of the Forth Bridge in the distance and of the lovely scenery around. The trip out and home occupied exactly 24 minutes. Again, it was feared that Glasgow could derive no benefit from the invention under inspection, for where, except on Finnieston Loch, could electric launches be floated without risk of poisoning the passengers? After dinner the accumulator car used on the Birmingham tramways, and exhibited by the Electric Construction Corporation, was inspected minutely, for here (Bailie Paton declared) was to be found the ultimate solution of the tramway difficulty. The Glasgow gentlemen seated themselves in the car, and listened with evident appreciation to the explanations which Mr. Bennett, standing in the midst, gave. Some of them, and especially Bailie Paton, had evidently studied the subject more than superficially, and from the remarks made it seems clear that electric traction is likely to have a fair field in Glasgow as soon as the Corporation acquire control of the trams. Neither at Glasgow in 1888, nor at Paris last year, was there any example of electric traction, and the authorities of our present exhibition have certainly reason to be proud of the display made. Several of the visitors expressed their astonishment at the extent and scientific character of the exhibition, not unmingled with remorse at having, in some mysterious way, been led to undervalue and depreciate its importance. "Certainly," said one of them, "we had the switchback, but nothing else of *importance* (?) in the railway line." On account, no doubt, of the existing tramway problem in this city, the attention of the Glasgow magistrates was on Tuesday specially directed to the illustrations of electric traction, in which the exhibition is so rich. No previous exhibition anywhere has boasted more than one example of electric traction; here we have three systems—pick-up current tramway, Telpher, and launch—in actual operation, while a fourth, the accumulator tramway, is shown quiescent in the machinery hall. A successful run was made by the car "Faraday" from the Caledonian end, passing the switchback station without stopping, the whole distance of half a mile being covered in three minutes. At the bandstand end Mr. Bennett explained the system in detail to Bailie Paton and other members of the Tramway Committee. The opinion expressed was that, although good enough for America, the overhead conductor system was not ornamental enough for Glasgow. The next jaunt was on the telpherway, two "specials" being run for their accommodation. On entering the trains there was quite a display of French politeness, each gentleman evidently being afraid of offending his neighbour by taking precedence. However, every one's modesty was at last overcome, and nearly the whole Corporation of Glasgow, Lord Provost, Bailies, and Councillors, were safely suspended on the wire rope with nothing but thin air between them and the dasies. The imagination stands appalled at the consequences of an accident at that moment. St. Mungo would have been like Edinburgh after Flodden, but with ne'er a Provost to comfort her. Happily, the tour was accomplished without a hitch. As the cars swung to and fro when rounding the curves, one could not help thinking that the prayer, "Let Glasgow Flourish," was being answered before one's eyes. It was the general opinion that the Telpher would not do for Glasgow either, except perhaps along the Broomielaw.

An Electric Insurance Company.—The Electric Mutual Insurance Company, of Boston, Mass., undertakes the whole risk on stations at fair rates, and return the profits at the expiration of the policy. "It belongs to no boards," it writes. "It makes its own rates. All of its directors are prominent electric light men. It is the electrical industries' own company. It also insures lamps, converters, meters, &c., outside of the station."

Proposed Lighting of the Manchester Town Hall.—At the ordinary meeting of the City Council, on Wednesday, Mr. Gunson moved:—"That the Town Hall Committee be instructed to report as to the best means of remedying the present unsatisfactory condition of the ventilating and heating arrangements of the Council Chamber and State rooms, as well as the various committee rooms and offices in the Town Hall; and also as to the advisability of the introduction of an installation for electric lighting." Dr. Simpson seconded the motion, which was accepted by the Mayor on behalf of the Town Hall Committee.

A Portable Electric Safety Mining Lamp.—"I have" says M. G. Trouvé, in presenting his memoir to the Academie des Sciences, "to recall to your minds that I have already, in connection with the Saint-Etienne disaster, had the honour to produce before you the first portable electric safety lamp. This lamp is in use in the State powder magazines at Sevran-Levry and Ripault, as also in the artillery and engineering schools of Versailles, Toul, Verdun, Epinal, Belfort. It is also used by the Parisian Gas Company, and, exclusively of any other, by the Paris fire brigade and the Italian Navy. It furnishes a current of 1·5 ampéres and 11·4 volts, *i.e.*, 17·10 watts, lasting three hours, = 51·30 watt-hours. This energy corresponds to an intensity of 4·2 candles for three hours, or of one candle for 11 to 13 hours, an illumination far superior to that of ordinary mining lamps. I am therefore in a position to affirm that this portable electric safety lamp will be found of equal service in mines as it has been to the firemen of Paris, the gas company, &c."

Copper.—Under this heading, a financial contemporary speaks at great length on the present condition of the copper industry. The market, now so buoyant, was certainly in a low state during the greater part of 1889, considering that the price of a ton of copper seldom got above the forties. Even when this year opened, the effect of the French Syndicate policy was very apparent, and it was not until there came visible signs of the diminution of the hoarded supplies that the market became firm. Now, however, things are in a very good state, and there is every appearance of a strong market at £60 per ton. Last year there were certainly handsome dividends paid by at least two prominent copper companies, and there is every likelihood that things will be much better this year than last. It is interesting to note the doings of the Copiapo Company. Last year was very nearly its last. There came on the top of the smash of the French Syndicate, a collapse of one of the mine shafts, a misfortune the result of which can scarcely be calculated. In spite of this, however, the shaft was made good, and it actually contrived to pay a respectable dividend of 6½ per cent., a very creditable wind up for the year 1889.

The *Pall Mall Gazette* says:—"In copper the rise in price which has been going on for some time past is not so much due to speculation as to a legitimate increased consumption with a falling off in the supply. The rise in price, brought about by the manipulation of the market by the French syndicate, so increased the production, and stocks were multiplied at so rapid a rate, that the copper combination found that it had committed itself to a task which it was unable to carry out. Hence the well remembered breakdown of last year. After the collapse the price of copper was, for a time, as low as £35 per ton, and most people thought that it would be years before the large surplus stocks which had accumulated would be disposed of, and the market right itself. But as the rise in price increased production and curtailed consumption, so the heavy fall led to a curtailment of production and increase in the demand, so that there has been a gradual diminution of stocks, until there is now but a small quantity in hand. Here, then, it appears that the recent rise in price is justified, and will be maintained."

The Telegraph Cable Question.—The *Daily Chronicle* of September 2nd says, in an evidently inspired "Note":—"The refusal of the Chancellor of the Exchequer to join in the subsidy to the Eastern Extension Telegraph Company, or to share in the guarantee which is necessary to secure the further reduction of the rates, has caused much comment in business circles in Adelaide, and while the parsimony of the Imperial Government is strongly condemned, it is pointed out that the South Australian Government will probably benefit by the refusal, because the Imperial Government must now decline to assist with the subsidy for the proposed Pacific cable, which, if laid, would probably take away a good deal of the telegraph business at present proceeding *viâ* Port Darwin." As regards the question of the subsidy for the proposed Pacific cable, "the wish was," of course, "father to the thought." There is, however, no doubt whatever that the late interruptions of communications have set people thinking that a Pacific cable is the only way to secure freedom from the disastrous effects of earthquakes in the Java seas.

NEW COMPANIES REGISTERED.

Sheffield Telephone Exchange and Electric Light Company, Limited.—Capital £100,000, in £10 shares. Objects: To take over the undertaking of the existing company of the same title, incorporated on the 11th September, 1888. Signatories (with 1 share each): *J. Tasker, *G. Senior, *G. Friklin, C.A., Wm. Johnson (engineer), T. G. Shuttleworth, C.A., R. E. Tasker, *W. Tasker, all of Sheffield. The signatories denoted by an asterisk and J. Gamble are the first directors. Qualification, 20 shares. Remuneration, £300 per annum, divisible. Registered 28th ult., by J. B. Roberts, 12, Coleman Street, agent for G. J. Simpson, Solicitor, Sheffield.

Freedman Battery Company, Limited.—Capital £2,000, in £1 shares. Objects: To acquire the interest of Charles H. Freedman in an invention of which no particulars are given in the registered documents. Signatories (with 1 share each): *E. F. Wyman, 74, Great Queen Street, Lincoln's Inn; T. F. Baker Evans, Anerley Park; *C. H. Freedman (electrical engineer), 13, Montague Place, W.C.; T. Douglas Murray, 33, Grosvenor Square; F. Suter (electrical engineer), 6, Ospringe Road; M. Davis, Montreal; H. H. Cooper (electrical engineer), 100, St. Donatt's Road, New Cross. The signatories denoted by an asterisk, and T. F. B. Evans, are the first directors. After 10 per cent. per annum dividend has been declared, the directors may receive such remuneration as may be voted them by the company in general meeting. Registered 1st inst. by Wm. Webb & Co., 6, Essex Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

South of England Telephone Company, Limited.—The annual return of this company, made up to the 1st August, was filed 1st September. The nominal capital is £400,000 divided into 300,000 ordinary shares of £1 each, and 20,000 preference shares of £5 each, the whole of which are taken up, the ordinary shares being considered fully paid. Upon the preference shares £3 10s. per share has been called and paid, the paid-up capital thus being £70,000.

Telephone Company of Austria, Limited.—The annual return of this company, made up to the 14th ult., was filed 23rd ult. The nominal capital is £200,000 divided into 20,000 ordinary and 20,000 preference shares of £5 each. The shares taken up are

11,703 ordinary and 6,558 preferred, upon which the full amount has been called. The calls received amount to £33,540, and £57,765 is considered as paid upon 11,553 ordinary shares.

Sheffield Telephone Exchange and Electric Light Company, Limited.—At an extraordinary meeting of this company, held at the offices, Commercial Street, Sheffield, on the 14th July, it was resolved to reconstruct, and for such purpose to wind up voluntarily. Mr. Thomas George Shuttleworth, of Sheffield, chartered accountant, and Wm. Johnson, of Sheffield (the secretary), being appointed liquidators.

Chili Telephone Company, Limited.—The annual return of this company, made up to the 22nd ult., was filed 29th ult. The nominal capital is £250,000, in £5 shares. 40,000 shares are taken up, upon which the full amount has been called and paid.

Nonpareil Electric Syndicate Company, Limited.—The registered office of this company is at 2, Victoria Mansions, Westminster.

CITY NOTES, REPORTS, MEETINGS, &c.

The Brush Electrical Engineering Company, Limited.

In the first annual report, to be presented to the shareholders at the general meeting of the company to be held at Cannon Street Hotel, London, on the 8th September, 1890, at 12 o'clock noon, the directors submit the balance sheet and profit and loss account, made up to 30th June last.

It is as follows:—

The company was registered on the 10th August, 1889, and the business of the Anglo-American Brush Electric Light Corporation, Limited, was taken over as from the 1st August, 1889, and that of the Falcon Engine and Car Works, Limited, as from the 14th June, 1889, and the accounts made up to the 30th June last are for the periods embraced by these dates. The arrangements for carrying on the business of the Australasian Electric Light and Power Company, Limited, were not completed until much later, and the accompanying accounts do not include any return of business effected by the Australasian branch.

The profit and loss account shows a gross profit of £36,698 16s., and after deducting all standing charges, maintenance of plant and buildings, and interest on debentures, there remains a balance of £14,235 6s. 1d. It is proposed to apply £625 to reduction of preliminary expenses, £500 to reduction of provisional orders account, and £3,000 to reduction of property, patents and goodwill account, to meet depreciation under these heads. The net balance of £10,426 19s. 3d. is available for dividends. An interim dividend, absorbing £3,808 6s. 10d. has already been paid upon the preference shares for the six months from 10th August to 10th February last, and it is proposed to apply £3,505 4s. 6d. to the payment of a further dividend upon these shares, making up the full preferential dividend at the rate of 6 per cent. per annum from the date of registration of company to 30th June, 1890. The directors recommend that the balance of £2,796 14s. 9d. be carried forward to next account.

The temporary interruption to business caused by the amalgamations with other companies and extensions of works has to some extent adversely affected the profit and loss account, and as several months had necessarily to elapse before the new works at Loughborough could be completed, the advantages of the lower cost of production at the country works were not obtained in regard to a large proportion of the orders executed. In view of all these circumstances, the directors consider the result of the year's working as encouraging.

The Falcon works at Loughborough have been considerably enlarged during the year at an expenditure of about £20,000, and the extension of these works enables the company to manufacture at a materially reduced cost engines, boilers, cars, and electrical machinery of practically every description and size. The directors are of opinion that this money has been well spent, and they anticipate good results in the future from the erection of these works.

It affords the directors much satisfaction to state that the Bill confirming the provisional order for lighting the central division of the City of London has been passed by Parliament. The agreement with the Commissioners of Sewers of the City of London provides that the work for the purpose of public lighting shall be commenced within nine months from the 21st May last, and the directors are making the necessary preparations for giving effect to this condition.

The company has also obtained a provisional order for Bournemouth, where a central electric light station has already been erected, which promises to yield very satisfactory returns. The directors have applied to the Board of Trade for provisional orders for several other towns in the United Kingdom where the company has interests to protect.

The Austro-Hungarian businesses have developed in a satisfactory manner, and the Vienna factory shows improving results, both as to volume of trade and as to net profit. The necessity for providing additional factory accommodation in Vienna has now arisen, and the directors are concluding negotiations for the acquisition of some freehold land and buildings adjoining the present works. They have also under consideration proposals for a re-arrangement of the company's interests in the Vienna business.

The directors have, with the assistance of Captain Rowan, the late general manager of the Australasian Company, fully examined into the character of the business acquired from that company, and have made arrangements for the proper development of the company's valuable patents and organisation in the Colonies.

West Coast of America Telegraph Company.

A MEETING of shareholders was held at Winchester House, on Monday, the 1st inst., at 1 o'clock. The proceedings were strictly of a private nature, and representatives of the press were excluded. We understand that the chairman (Mr. A. Marshall) made a statement as to the position and prospect of the company which was regarded as somewhat reassuring. A short discussion, quiet in character, followed, and the meeting broke up without any resolution being passed.

The following letter appeared on Saturday:—

To the Editor of THE FINANCIAL NEWS.

"Sir,—I beg to enclose a printed notice issued by the directors of this company, whose shares, at the beginning of this year, were quoted at 11¼, while they are now scarcely saleable at 3¼. This excessive depreciation in value is said to be due to threatened competition; but the eagerness of the shareholders to part with their holdings is, in my opinion, mainly owing to the want of confidence in the management of the company.

"The directors—three in number—take in fees no less a sum than £1,475 per annum. Their business capacity may be judged from the accompanying notice convening a meeting on Monday next, without mentioning the hour at which the shareholders are to attend. From the notice, it would appear as if the shareholders were expected to pass the whole day at 50, Old Broad Street, discussing the company's affairs.

"As the company paid a dividend of 6 per cent. last year, and added £25,000 to the reserve fund, a sum equal to 8 per cent. on the capital, I thought that the shares were worth a small premium, and unfortunately became a purchaser at 10¾. I ought, before buying, to have inquired into the administrative ability of the directors, who have succeeded in bringing down the price of the shares some 70 per cent. The published traffics of the company show little or no decrease over the earnings of last year.

"Living in Devonshire, I cannot attend the meeting on Monday next, but I hope that the London shareholders will assemble in force and insist on some reform of the present board of directors.

"I am, sir, yours, &c.,

"A COUNTRY SHAREHOLDER."

Hartlepool Gas and Water Company.—At the annual general meeting of the company held recently at Hartlepool, Mr. W. H. Fisher, the chairman, after congratulating the shareholders on a prosperous year, and prognosticating the sustained activity of trade in the district for another year, observed as to the future, that the cost of production of gas would be increased by fully £3,000 in coal, and the necessity of raising the price by 2d. per 1,000 feet had been seriously discussed, but abandoned for the present, in the hope that the increased cost would be partially met by increased consumption—otherwise, the question must be shortly reconsidered.

The Bankers and Merchants' Telegraph Company.—The property and franchises of the company have been sold at auction under foreclosure. Colonel Robert G. Ingersoll bid it in for $390,000.

The Brush Electrical Engineering Company, Limited.—The transfer books will be closed to the 9th inst., inclusive.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of August were £2,900, as compared with £2,815 in the corresponding month of last year. The receipts for the month of May, estimated at £3,400, realised £3,469.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of August were £2,075, against £1,624 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of August, 1890, amounted to £46,526, as against £39,489 in the corresponding period, an increase of £7,037.

The Eastern Telegraph Company, Limited. The receipts for the month of August were £52,606, as against £52,012 for the same period of 1889, or an increase of £594.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 31st August are £2,420 as against £2,161, an increase of £259 as compared with the corresponding period.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 29th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,772.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of August, 1890, were £4,960.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 28).	Closing Quotation. (September 4.)	Business done during week ending September 4, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 —100	97 —100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50½— 51¼	51 — 52	51	50
2,725,420	Do. do. 6 p. c. Preferred	Stock	87¼— 88⅛	87½— 88⅛	88⅛	87⅛
2,725,420	Do. do. Deferred	Stock	15½— 15⅝	15½— 15⅝	15⅝	13⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12¼	11⅜— 12½	12	...
99,000	Do. do. 5 p. c. Bonds...	100	100 —102	100 —102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 —107	103 —107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	1½— 2	1½— 2		
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1½— 2	1½— 2		
$7,216,000	Commercial Cable, Capital Stock	$100	102 —104	103 —105	103⅞	103¼
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	9/16— 11/16	9/16— 11/16		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½— 5⅝	5½— 5⅝		
16,000	Cuba Telegraph, Limited	10	12½— 13	12½— 13		
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	17⅛	16¾
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10½	10¼— 10⅝	10½	10 7/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅞— 14⅛	13⅞— 14⅛	14¼	13⅞
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 —109	106 —109	109	108
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	105 —108	105	.....
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14¼	14 — 14¼	14¼	14
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 —103	100 —103		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7⅜—8¼	8 — 8½		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5¼	4⅜— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	6¾— 7¼	7⅛— 8¼	8¼	7
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2 — 2½	2 — 2⅜		
180,227	Globe Telegraph and Trust, Limited	10	8⅞— 9⅛	8⅞— 9⅛	9⅛	8 1/16
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15	15	14 15/16
150,000	Great Northern Tel. Company of Copenhagen	10	15¼— 16	15⅞— 16¼	16¼	16 1/16
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 —103	100 —103		
250,000	Do. do. do. (issue of 1883) ...	100	106 —109	104 —107 xd		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11¼— 12¼	11¼— 12¼		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18¼— 19¼	17⅛— 18¼	18¼	18¼
200,000	Do. do. 4½ p. c. Deb., 1896...	100	102 —104	102 —104		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6⅛— 7⅛		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	105 —108 xd		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4 — 4⅛	4 — 4⅛	4¼	...
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4⅜— 5	4⅜— 4⅝	4⅜	4 11/16
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜	⅜	...
9,000	Reuter's, Limited	8	7⅞— 8¼	7⅞— 8¼		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ⅜		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½— 3	2½— 3		
3,381	Submarine Cables Trust	Cert.	113 —117	113 —117	116	115
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5 — 5½	5 — 5⅛	5 7/16	5⅜
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43¾	42½
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	100 —102		
55,000	United River Plate Telephone, Limited	5	3⅛— 4⅛	3⅛— 4		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. do. 5 p. c. Debentures	100	100 —103	99 —102 xd	100¼	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	4 — 5	4	3½
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	103 —108	101 —106	104⅛	103⅜
64,572	Western and Brazilian Telegraph, Limited	15	11⅛— 11¾	11 — 11⅛	11⅜	11¼
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 7¼	6¾— 7	6 13/16	...
26,986	Do. do. do. 5 p. c. Deferred	7½	4¾— 5¼	4½— 5	4¾	4⅜
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	103 —106	103 —106		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 —104	101 —104		
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	2⅝— 3⅛	3 1/16	2⅞
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11½— 12	11⅝	11 9/16
4,669	Do. do. do, 6 p. c. 2nd Preference ...	10	13 — 14	13 — 14		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	97 — 99 xd		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¼— 1⅜	1¼— 1⅜		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—Elmore Copper Depositing Priorities, 7 —7¼.—Elmore Wire, ¼ dis—par.—House-to-House Company (£5 paid), 5 —5⅛.—International Okonite, Ordinary of £10 (£7 paid), 6¾—7¼ London Electric Supply Corporation, Ordinary (£5 paid), 1¼—2¼.—Manchester Edison and Swan Company, £9 (£1 paid), 11/- —13/-.

BANK RATE OF DISCOUNT.—4 per cent. (21st August, 1890).

THE ANNEALING OF COPPER.*

By G. WYCKOFF CUMMINS, New York.

COPPER is at present almost universally annealed in muffles, in which it is raised to the desired temperature and subsequently allowed to cool either in the air or in water. It may be stated, for the benefit of those not versed in the practical work of annealing, that a muffle is nothing more nor less than a reverberatory furnace. It is necessary to watch the copper carefully, so that when it has reached the right temperature it may be drawn from the muffle and allowed to cool. This is extremely important, for it is found that if the copper is heated to too high a temperature, or is left in the muffle at the ordinary temperature of annealing for too long a time, it is "burnt," as the workmen say. Copper that has been "burnt" is yellow, coarsely granular, and exceedingly brittle—so much so that in some samples in my possession it cannot be bent once at a right angle without breaking. It is even more brittle at a red heat than when cold.

In the case of coarse wire it is found that only the surface is "burnt," while the interior is damaged to a far less extent. This causes the exterior to split loose from the interior when bent or when rolled, thus giving the appearance of a brittle copper tube with a copper wire snugly fitted into it. Cracks a half-inch in depth have been observed on the surface of an ingot on its first pass through the rolls, all due to this exterior "burning." It is quite apparent that copper that has been thus overheated in the muffle is entirely unfit for rolling, either for rods or sheet copper or for wire drawing. It is found that the purer forms of copper are far less liable to be harmed by overheating than samples containing even a small amount of impurities. Even the ordinary heating in a muffle will often suffice to "burn" in this manner the surface of some specimens of copper, and thus render them entirely unfit for further working. The explanation of this will be made later. Copper that has been thus ruined is of use only to be refined again.

As may be inferred from the above, only the highest grades of refined copper are at present used for drawing or for rolling. This is not because the lower grades, when refined, cannot stand sufficiently high tests, but because the present methods of working are not adequate to prevent these grades of copper from experiencing the deterioration due to overheating. This is unfortunate for the manufacturer since, I understand, he has to pay cash in advance for the highest grades of refined copper.

In order better to appreciate the explanation of the various phenomena of copper annealing, let us see what refined copper is. The process of refining copper consists in an oxidising action followed by a reducing action which, since it is performed by the aid of gases generated by stirring the melted copper with a pole, is called poling. The object of the oxidation is to oxidise and either volatilise or turn to slag all the impurities contained in the copper. This procedure is materially aided by the fact that the suboxide of copper is freely soluble in metallic copper, and thus penetrates to all parts of the copper, and, parting with its oxygen, oxidises the impurities. The object of the reducing part of the refining process is to change the excess of of the suboxide of copper to metallic copper. Copper containing even less than 1 per cent. of the suboxide of copper shows decreased malleability and ductility, and is both cold short and red short. If the copper to be refined contains any impurities, such as arsenic or antimony, it is well not to remove too much of the oxygen in the refining process. If this is done, "overpoled" copper is produced. In this condition it is brittle, granular, of a shiny yellow colour, and more red short than cold short. When the refining has been properly done, and neither too much nor too little oxygen is present, the copper is in the condition of "tough pitch," and is in a fit state to be worked.

"Copper is said to be tough pitch when it requires frequent bendings to break it, and when, after it is broken, the colour is pale red, the fracture has a silky luster, and is fibrous, like a tuft of silk." On hammering a piece to a thin plate it should show no cracks at the edge. At tough pitch copper offers the highest degree of malleability and ductility of which a given specimen is capable. This is the condition in which refined copper occurs in the market, and if it could be worked without changing this tough pitch any specimen of copper that could be brought to this condition would be suitable for rolling or drawing. We have seen that tough pitch is changed if we either add oxygen to or take oxygen from refined copper.

By far the more important of these is the removal of oxygen, especially from those specimens that contain more than a mere trace of impurities. This is shown by the absolutely worthless condition of overpoled copper. The addition of carbon also plays a very important part in the production of overpoled copper.

That the addition of oxygen to refined copper is not so damaging is shown by the fact that at present nearly all the copper that is worked is considerably oxidised at some stage of the process, and not especially to its detriment.

Let us see how the above facts are related to the process of annealing copper. I have already referred to what is known as "burnt copper." This you may already have recognised as nothing more nor less than copper in the overpoled condition. This is brought about by the action of reducing gases in the muffle. By this means the small amount of oxygen necessary to give the copper its tough pitch is removed. You must remember that this oxygen is combined with impurities in the copper, and thus renders them inert. For example, as explained by Dr. Peters, the oxide of arsenic or antimony is incapable of combining more than mechanically with the copper, but when its oxygen is removed, the arsenic or antimony is left free to combine with the copper. This forms a very brittle alloy, and one that corresponds almost exactly in its properties to overpoled copper. To be sure, overpoled copper is supposed to contain carbon, but that this is not the essential ruining principle in case of annealing is shown by the fact that pure copper does not undergo this change under conditions that ruin impure copper, and also by the fact that the same state may be produced by annealing in pure hydrogen, and thus removing the oxygen that renders the arsenic or antimony inert. No attempt is made to deny the well known fact that carbon does combine with copper to the extent of 0·2 per cent., and cause it to become exceedingly brittle. It is simply claimed that this is probably not what occurs in the production of so-called burnt copper during annealing. The amount of impurities capable of rendering copper easily "burnt" is exceedingly small. This may be better appreciated when it is considered that from 0·01 to 0·2 per cent. expresses the amount of oxygen necessary to render the impurities inert. The removal of this very small amount of oxygen, which is often so small as to be almost within the limits of the errors of analysis, will suffice to render copper overpoled, and ruin it for any use.

Perhaps the most interesting part of this article, to practical men at least, will be the description of a method of avoiding the numerous accidents that may occur in the annealing of copper, due to a change of pitch. As already pointed out, the quality of refined copper is lowered if oxygen be either added to or taken from it. It is quite apparent, therefore, that a really good method of annealing copper will prevent any change in the state of oxidation. To accomplish this it is necessary to prevent access to the heated copper both of atmospheric air, which would oxidise it, and of the reducing gases used in heating the muffle, which would take oxygen away from it. Obviously the only way of accomplishing this is to enclose the copper when heated and till cool in an atmosphere that can neither oxidise nor deoxidise copper. I find that by so doing copper may be heated to the melting point and allowed to cool again without suffering at all as regards its pitch. There are comparatively few gases that can be

* *Scientific American.*

used for this purpose, but, fortunately, one which is exceedingly cheap and universally prevalent fulfills all requirements, viz., steam. In order to apply, then, in practice, the principles already enunciated, it is necessary only to anneal copper in the ordinary annealing pots, such as are used for iron; care being taken to enclose the copper while heating and while cooling in an atmosphere of steam. This will effectually exclude air and prevent the ingress of gases used in heating the annealer. Twenty-four hours may be used in the process, as in the annealing of iron wire, with no detriment to the wire. This may seem incredible to those manufacturers who have tried to anneal copper wire after the manner of annealing iron wire. By this method perfectly bright annealed wire may be produced. Such a process of annealing copper offers many advantages. It allows one to use a grade of copper that has hitherto been worked only at a great disadvantage, owing to the ease with which it gets out of pitch. It allows one to use annealers such as are ordinarily used for annealing iron, and thus cheapens the annealing considerably as compared with the present universal use of muffles. There is no chance of producing the overpoled condition from the action of reducing gases used in heating the muffles. There is no chance of producing the underpoled condition due to the absorption of suboxide of copper. None of the metal is lost as scale, and the saving that is thus effected amounts to a considerable percentage of the total value of the copper. The expense and time of cleaning are wholly saved. Incidentally bright annealed copper is produced by a process which is applicable to copper of any shape, size, or condition, a product that has hitherto been obtained only by processes (mostly secret) which are too cumbersome and too expensive for extensive use and, as is the case with at least one process with which the author is acquainted, with the danger of producing the overpoled condition, often in only a small section of the wire, but thus ruining the whole piece.

If it is desired, the copper may be annealed in an apparatus so arranged that the copper when heated may be dropped into a body of water without access of air, and thus make a far smaller annealing plant suffice. It may be mentioned that copper seems to be made neither softer nor harder by being cooled suddenly in this manner than if cooled slowly, though some of the alloys of copper are rendered somewhat softer by a sudden cooling; in fact, there is not the slightest evidence anywhere to justify the quite prevalent belief that an art of hardening copper was known to the ancients. The hardest tools of the ancients were made of bronze, not copper.

By application of the same principles it is possible to prevent both deoxidation and oxidation in the heating of copper ingots for the rolls, and thus, by keeping copper at tough pitch all along, any copper that can be given tough pitch can be used for rolling as sheet copper or for wire.

I think it also practicable to produce bright copper rods direct from the rolls.

PEDDIE'S CONDUIT RAIL.

THIS conduit rail is for use on tramways and railways worked by electricity. The conductor, properly insulated, is placed within the rail, thus avoiding the expense and inconvenience of a separate central conduit, and the brush is applied to the underside. The wooden T-insulator (which is further itself insulated from the rail) is secured to the rail by a wooden dowell. The horizontal copper conductor is attached to the insulator by a kneed bracket, screwed to the insulator, the conductor being recessed so as to give a flush surface for the brush to travel over. Provision is made for points and crossings, and also for preventing the brush, &c., coming in contact with the rail. The slot in the rail answers both for wheel flange and also for the vertical conductor to the motor on the car. At suitable distances small iron cases, termed "mud traps," are placed opposite holes in the side of the rail. These permit of the rail being easily cleaned, and also of the renewal of the conductor without the permanent way being lifted. The rail can be flushed with water, and thus easily and effectively cleaned without affecting the conductor. It can also be easily applied to existing horse tramways.

The figs. shows a cross section. A is the rail, with the conductor within it. C is the bracket (pendant from the car with motor) carrying the brush, which is applied to the underside of the conductor. M is the "mud trap" with movable cover, and pipe, P, to gutter. These pipes need only be at requisite distances, not at every "mud trap." Fig. 2 shows the arrangement for railways. In this case, the brush is applied from the outside instead of from the inside of the rail. The reason of this is, that in the case of railways, the pressure will be much greater than in the case of tramways. It is therefore desirable to have the body of the rail directly under the tread of wheel.

The object of the conduit rail is to provide a *simple, safe, and efficient* method of working electric tramways and railways, *at the least possible expense*, avoiding all the inconvenience and expense of costly central conduits, or poles and other overhead apparatus, for the

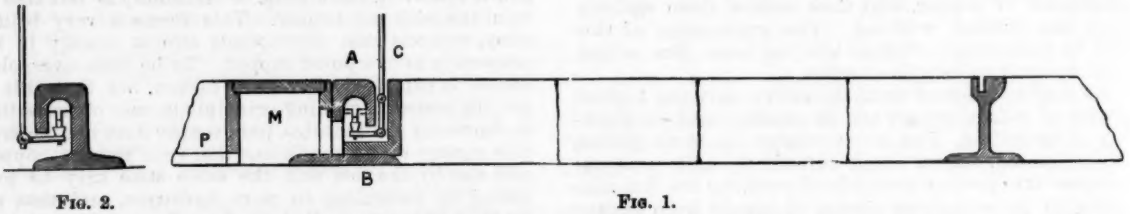


FIG. 2. FIG. 1.

conductors. The following points have also been borne in mind:—

1. Placing the conductor where it will be safe from injury both to itself and the public.

2. Making provision for easily cleaning and flushing the rail without affecting the conductor within it. This is secured by means of the "mud traps," which at suitable points have pipes to the gutters.

3. Making provision for easily renewing the conductor when it is worn, without lifting permanent way. Thus, by removing the covers of the "mud traps," the brackets which hold the conductor to the T-insulator can be unscrewed, the conductor lowered, and then raised and removed through the slot. A new conductor can then be lowered and fixed in a similar manner. The T-insulators can also be removed and renewed by means of the "mud traps."

4. Making the rail suit for ordinary horse or steam or compressed air, or accumulator cars. As far as these cars are concerned, the "conduit rail" is practically an ordinary slot rail.

5. Avoiding any central slot rail (between the wheel rails), which is a great inconvenience to ordinary street traffic.

6. Making the system such that it can be easily and effectively, and without great cost, applied to existing tramways. This is done by simply lifting one of the ordinary slot rails and replacing it with a conduit rail with conductor. By doing this on short sections at night, all interruption of ordinary or car traffic is avoided.

7. General simplicity and freedom from liability to derangement.

ELECTRICALLY-OPERATED TREVELYAN INSTRUMENTS WITH CARBON "ROCKERS" AND "BEARERS."

By A. M. TANNER.

EVERYTHING concerning the genesis of the microphone and carbon telephone should be presented to the scientific and technical world, so that hereafter there shall be no further misconception as to the actual discoveries made by Prof. Hughes and Mr. Edison; the former having used hard carbon contacts in his microphone, and the latter having resorted to compressible, or soft carbon, in his original carbon telephone.

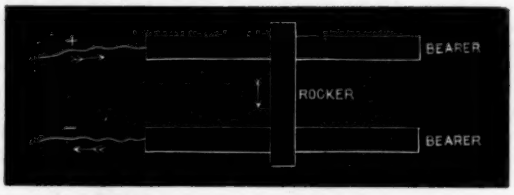
I have already shown, in an article which appeared in the ELECTRICAL REVIEW of August 22nd, that as far back as the year 1858 Rollman drew attention to the fact that a hard carbon prism resting loosely upon carbon bearer points included in a closed electric circuit will, by its vibratory movement produced by the passage of the electric current, serve to vary the points or surfaces of contact, and thus effect a change of tension of the electric current flowing in the circuit.

I now wish to call attention to another electrically-operated Trevelyan instrument, which has a carbon rocker vibrating upon carbon bearers.

In the London, Edinburgh, and Dublin *Philosophical Magazine* for 1859, Fourth Series, Vol. XVII., page 358, is an article by Prof. J. D. Forbes, of the University of Edinburgh, entitled, "Notes on Certain Vibrations Produced by Electricity." After reviewing prior experiments of Prof. Gore with a Trevelyan instrument having a hollow copper sphere, made to run on a circular track by the action of electricity. Prof. Forbes continues as follows, viz.:—

"I have obtained very active vibrations of carbon (such as is used in one of the elements of Bunsen's battery) resting upon brass, and also when it rests upon two pieces of carbon connected with the terminals of a battery. For this purpose, a battery having a certain amount of intensity is requisite, in order to overcome the resistance of carbon as a conductor, but the vibrations are most energetic. The extremely small expansion which takes place in carbon by heat is another argument against that view of the Trevelyan experiment."

The above-quoted description is not accompanied by an illustration, but from collateral evidence it undoubtedly warrants the sketch given below of the the arrangement of bearers and rocker.



It will readily be perceived how closely this resembles the "three-nail microphone of Prof. Hughes. I think it will be conceded that, in view of the instruments constructed by Rollman, Paalzow, and Forbes, the novelty of the microphone must be sought in the method of varying the force of an electric current by the action of sonorous vibrations; in other words, it appears almost impossible to uphold a claim for a microphone instrument in which a carbon electrode rests loosely upon another electrode, for the purpose of varying the tension of the current in a closed electric circuit in which said electrodes are included.

I believe it has been held by an English Court that "the circumambient air" is the equivalent of a diaphragm in a telephone, having a current tension regulator of carbon. If this is true, then the instruments of Rollman, Paalzow, and Forbes must have an exceedingly close bearing upon a microphone or carbon telephone whose novelty rests solely upon a variable contact rheostat of carbon, introduced into a closed electric circuit. When it comes to the principle or method of operating the carbon rheostat by sonorous vibrations, then the Trevelyan instruments considered in my articles lose their pertinency. They can only be used to show that the device employed in a microphone (without a diaphragm) are old in other instruments, and that the action of a variable contact rheostat made of hard carbon, for changing the tension of the current in a closed electric circuit was discovered by Rollman.

KEMMLER'S EXECUTION AS SEEN BY AN ELECTRICIAN.

By CHARLES R. HUNTLEY.

IT is with pleasure that I comply with the request of the *Electrical World* to give my observations on the Kemmler electrocution. One of the prime reasons which prompted me to attend this event was that the electrical fraternity would have the benefit, so far as I was able to observe, of what occurred at this electrocution.

The dynamo, as is well known, is one of the Westinghouse type, the exciter being of the usual pattern sent with all dynamos of this make. It was located in the second story of the east wing of the prison, about 1,000 feet from the room wherein the death chair was located. The power was supplied by a 45 H.P. engine, belted to a 2-inch shaft, which ran through the dynamo room. On this shaft were a 36-inch pulley and a 30-inch pulley. From the 36-inch pulley was run an 8-inch belt down to a 12-inch pulley on the dynamo, and a 6-inch belt ran from the shaft to the exciter. No voltmeter or ammeter was connected up in circuit at this point. A resistance box was placed at the end, over the exciter. The wires led out through the window up over the roof on porcelain and glass insulators, down across and around the dome of the front of the prison; from there down on the wall into the window of what was known as the original room for the electrocution. This wire was of No. 12 B. and S. gauge, rubber covered, and said to have been made by the Edison Company. On the switchboards were two Cardew voltmeters, both connected up with resistance coils. Both were connected with switches, and between the two was a lamp board, which, I am told, is of the usual type used in the Edison stations. In this were 20 100-volt lamps of Edison make, and an ammeter of Bergman & Co.'s make was a part of the lower portion of the board.

There were two jaw switches—one known as the fatal switch and the other as the lamp board switch—which were placed on the wall of easy access to the executioner. From the board there ran wires of the same gauge into the chair, one being fastened to the electrode on the bottom, and the other to the electrode on the top. This is all of the electrical apparatus and distribution that I noted. A Mr. Davis was the man in charge. I might say that my curiosity prompted me to go with him to witness the first test of the machinery on Tuesday afternoon. Mr. Davis adjusted the brushes on both dynamo and exciter, and then left the apparatus in charge of three convicts who were assistants.

After going back to the switchboard signals were given to start up the dynamo. At that time the voltmeter showed about 1,000 volts. The lamps were in circuit and were about two-thirds candle-power. Again, in the evening, all of the witnesses summoned by law, together with the doctors and professional men, witnessed another test, which was substantially the same as that of the afternoon. There was no record taken of what the voltage was at that time, but an assumption was made that it was from 1,000 to 1,200 volts.

The morning of the execution came, and those who were to witness the first experiment upon human life by the electric current found, in a dimly lighted room,

the death chair, and around about the walls in a circle seats for their accommodation. I do not know that it will be of any interest to your electrical readers to record here (inasmuch as the Press has given all of that) what took place with reference to the in-coming of Kemmler and his spiritual advisers, but suffice to say that the man who stood before us exhibited the most unconcern of any of the 23 men who were within the room. After being strapped and pinioned to the chair, Kemmler assisting, and to quite an extent, the electrodes at the head and back were securely placed, the strap securely fastened over his face by the warden, the word was given to the three men who were in the room behind a closed door, and we witnessed the effect of the first contact by a contraction, or rather drawing up of his whole body within his bonds. The time by actual count was 17 seconds. The current then, by direction of Dr. Spitzka, was turned off, and to all appearances Kemmler was dead. As the doctor said: "There are unmistakable evidences of death about his nose, and I have never known such a condition as is demonstrated on this man except in death." One of the attendants then removed the electrode from his head, and those who were advocates of the killing by electricity were elated beyond expression. The look of entire satisfaction which spread over the countenances of some of the learned doctors was an indication of the joy that their labours had brought them in the death of Kemmler, apparently so painless and still. The next sound that was heard was of Dr. Spitzka saying: "This man is not dead. Turn on the current." The electrode, in a hurried manner, was again applied to his head, and the signals were sent out by one of the attendants in the room to start up the machinery. This was done. How soon I cannot say. The laymen were all in confusion at the horrible sounds that were coming from the man who had been pronounced dead. Words fail me with which to give you the faintest idea of what these were. There were men in that room who had witnessed executions and had seen death in various forms, but each and every one of them was horror stricken at this sudden change in the condition of the culprit. Various reports have been made as to the length of time of the second contact, but it has been my privilege to be associated somewhat with the gentleman who was in the dynamo room while the machine was in operation. He tells me that after the first shock the signals were given to shut down. This was done by the convicts. Then a short space—perhaps two minutes—and the signal was given to start again. Instantly another signal was given for more speed, and so on, until the dynamo was running, and as he stated, it was fairly jumping from the floor. I forgot to mention that during the time of the second shock the circuit was made and broken three times. At each of these periods the dynamo would be nearly stopped, and the belt after the first shock was nearly thrown off the dynamo pulley. Then a convict was instructed to hold the belt on each side of the pulley, which was done during the time that the dynamo was running, which was about three and a half minutes. Added to the horror of the sounds emitted by the so-called dead man, were what the doctors said were convulsions, but whatever it may be called, convulsions or not, I am told by one of the physicians, as reputable as any there, that life did exist in the man, though not sensibility, after the first shock. The electrode at his back had become loosened, admitting of arcing, and at this point of contact the flesh was literally roasted. The stench of burning flesh was almost unbearable to those of us unfamiliar with such things.

What occurred in the lamp room no one will ever know beyond the three persons present. I endeavoured to ascertain what the voltage was, but I did not succeed in getting any information, and I question very much whether Mr. Davis himself, who had charge of the electrical appliances, knows to what voltage Kemmler was exposed at either time.

From an electrical standpoint there was nothing gained to show what amount of current it takes to kill. No data of either the electrical or mechanical apparatus was taken, and whoever assumes to say what the voltage was that Kemmler received must guess between 800 and 2,000.

MR. EDISON ON THE KEMMLER EXECUTION.

Mr. T. A. Edison, when interviewed, said: In December, 1887, I wrote to a man who asked for my views, that I would join heartily in a movement to abolish capital punishment. If it was not to be abolished, however, I said, we should adopt the quickest and least painful method of accomplishing it, and I believed an intermittent dynamo current properly applied would best meet these requirements. I still believe this. In the Kemmler execution, according to the reports printed in the newspapers, the fault rests upon the doctors. They acted upon theory, and knowing the base of the skull to be the nerve centre of the human system, they determined to reach it as directly as possible. Theoretically they were right, but practically they were wrong, as experience has demonstrated. In not a single one of the 30 perfect examples of the power of electricity to produce instant death that have occurred in and around New York was it applied to the head. Of what use has the death of these 30 men been? In every instance the fatal charge entered through the hands. In no case among these accidental deaths was the current that passed through the body one-half what it was announced was to be used on Kemmler. Electricity travels through fluids, and especially through the saline fluids of the body, much more freely than through bone. The hands, when cleansed and immersed in a solution of caustic soda, afford an excellent contact for electric currents, and as the fingers, hands and arms are full of blood, they make a good conductor of electricity. On the other hand, bone is one of the poorest conductors, and by making the points of contact on the thickest part of the skull, and the portion of the spine affording most resistance, the doctors invited a degree of failure. Neither contact could have been made in a less desirable place. The hair of the head is also a non-conductor, and offers resistance to electrical currents. If, as is stated, Kemmler's skin was burned at the points of contact, that proves that he received but a small portion of the charge. Had he received the full 1,300-volt current for the length of time stated, he would have been carbonised or mummified. If the report that 20 incandescent lamps were in the circuit and illuminated at the time the current was applied to Kemmler is true, the explanation is in part at least furnished. These lamps offer resistance to the flow of the current, and 20 of them would greatly reduce the potential of the current. They should have been removed from the circuit.

"How do you account for the muscular and apparently respiratory action after the current had been once turned on?" was asked. "Oh, I have no doubt he was dead," replied Mr. Edison. "I think the doctors will probably agree to that. You know there is often muscular movement after death by hanging. Kemmler was undoubtedly killed at the first, unless some big mistake was made. Undoubtedly all those present were greatly excited. I should have been excited myself at such a time. In that excitement there may have been some bungling. I think, when the next man is placed in the chair to suffer the death penalty, that death will be accomplished instantly and without the scene at Auburn."

Proposed Electric Tramway at Plymouth.—Arrangements are in progress for constructing a new tramway at Plymouth, and bringing the old lines, which have been for a considerable period in disuse, once more into working order. The work is to be carried out by Messrs. Grover & Co., and it is said to be the intention of the promoters of the new scheme to apply for the necessary powers to enable them eventually to use electricity as the motive power.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

THE sixtieth meeting of the Association opened at Leeds on Wednesday. A good many years have elapsed since the last meeting in this town, during which time the district, from a manufacturing point of view has greatly developed. There will probably not be a great number of electrical papers read at the meeting, but those promised bid fair to rank as valuable additions to technical literature.

On Wednesday evening Sir Frederick A. Abel, C.B., D.C.L., F.R.S., gave the presidential address, an abstract of which follows. Thursday was spent in hearing the addresses of the presidents of the various sections, and it will not be before to-day that they settle fairly down to work.

ABSTRACT OF ADDRESS*

BY SIR FREDERICK AUGUSTUS ABEL, C.B., D.C.L. (Oxon.), D.Sc. (Cant.), F.R.S., P.P.C.S., Hon.M.Inst.C.E.,

President.

Among the branches of science in the practical applications of which the greatest strides have been made since the Association met at Leeds in 1858, is electricity. That year witnessed the accomplishment of the first great step towards the establishment of electrical communication between Europe and America, by the laying of a telegraph cable connecting Newfoundland with Valencia. Through this cable a message of 31 words was shortly afterwards transmitted in 35 minutes; an achievement which, though exciting great enthusiasm at the time, scarcely afforded promise of the succession of triumphs of ocean telegraphy which have since surpassed the wildest dreams of the pioneers in the realms of applied electricity.

The development of the electric telegraph constitutes a never-failing subject of the liveliest interest. The experiments made by Stephen Gray, in 1727, of transmitting electrical impulses through a wire 700 feet long; by Watson, 20 years afterwards, of transmitting frictional electricity through many thousand feet of wire, supported by a line of poles, on Shooter's Hill, in Kent; and by Franklin, who carried out a similar experiment at Philadelphia—although they were followed by many other interesting and philosophical applications of frictional electricity to the transmission of signals—were not productive of really practical results. The work of Galvani and of Volta was more fruitful of an approach to practical telegraphy in the hands of Sömmering and of Coxe, while the researches of Oersted, of Ampère, of Sturgeon, and of Ohm, and especially the discoveries of volta-electric induction and magneto-electricity by Faraday, paved the way for the development of the electric telegraph as a practical reality by Cooke and Wheatstone in 1837. How remarkable the strides have been in the resources and powers of the telegraphist since that time is demonstrated by a few such facts as these; the first needle instrument of Cooke and Wheatstone transmitted messages at the rate of four words per minute, requiring five wires for that purpose; six messages are now conveyed by one single wire, at ten times that speed, and news is despatched at the rate of 600 words per minute. Duplex working, which more than doubled the transmitting power of a submarine cable, was soon eclipsed by the application of Edison's quadruplex working, which has in its turn been surpassed by the multiplex system, whereby six messages may be sent independently, in either direction, on one wire. When last the British Association met in Leeds, submarine telegraphy had but just started into existence; 30 years later, the accomplished President of the Mechanical Section informed us, at our meeting at Bath, that 110,000 miles of cable had been laid by British ships, and that a fleet of nearly forty ships was occupied in various oceans in maintaining different cables and laying new ones.

The important practical achievements by which most formidable difficulties have been surmounted, step by step, in the successive attainment of the marvellous results of our day, have exerted an influence upon the advancement, not merely of electrical science, but also of science generally and of its applications, fully equal to that which they have exercised upon the development of commerce and of the intercourse between the nations of the earth.

Thus the laying of the earliest submarine cables between 1851 and 1855, led Sir W. Thomson, in conference with Sir George Stokes, to work out the theory of signalling in such cables, by utilising the mathematical results arrived at by Fourier in his investigation of the propagation of heat waves. The failure of the first Atlantic cable led to the survey of the bottom of the Atlantic, which was the forerunner of deep-sea explorations, culminating in the work of the *Challenger* expedition, and opening up new treasures of knowledge scarcely dreamt of when last the British Association met at Leeds. To the difficulties connected with the early attempts at submarine telegraphy, and the determination with which Thomson drove home the lessons learned, we owe the systematic investigations into the causes of the variations in resistance of copper conductors, and the consequent improvements in the metallurgy of copper, which led to the realisation of the high standard of purity of metal essential for the efficient working of telegraphic systems, and also to the extensive utilisation of electricity in the production of pure copper. The rare combination of originality in powers of research and perspicuity in mathematical reasoning, with inventive and constructive genius, for which Thomson has so long been pre-eminent, has placed at the disposal of the investigator of electric science, and of the practical electrician, instruments of measurement and record which have been of incalculable value, and which owe their origin to the theoretical conclusions arrived at by him in his researches into the conditions to be fulfilled for the attainment of practical success in the construction and employment of submarine cables. The mirror galvanometer, the quadrant electrometer, the syphon-recorder, and the divided ring electrometer, are illustrations of the valuable outcome of Thomson's labours; the combination of the last-named instrument with sliding resistance coils has rendered possible the accurate sub-division of a potential difference into 10,000 equal parts. The general use of condensers in connection with cable signalling, due to Varley's application of them for signalling through submerged cables with induced short waves, was instrumental in establishing the fact that all electrostatic phenomena are simply the result of starting an electric current of known short duration round a closed circuit. The practical application of the Wheatstone bridge led to numerous important mathematical investigations, and induced Clerk Maxwell to devise a new mode of applying determinants to the solution of the complicated electrical problems connected with the networks of conductors. The necessity for the universal recognition of an electrical unit of resistance led to the establishment, in 1860, of the Electrical Standards Committee of the British Association, whose long succession of important annual reports was instrumental in most important developments of theoretical electricity, and, indeed, served to open up the whole science of electrical measurement. Matthiessen's important investigations of the electrical behaviour of metals and their alloys, and the preparation and properties of pure iron, were the outcome of the commercial demand for a practically useful standard of electrical resistance, while Latimer Clark's practical standard of electromotive force, the mercurous sulphate cell, became invaluable to the worker in pure electrical research. The unit of resistance established by the British Association Committee received, in 1866, most important scientific application at the hands of Joule, who, by measuring the rate of development of heat in a wire of known resistance by the passage of a known current, obtained a new value of the mechanical equivalent of heat. This value differed by about 1·3 per cent. from the most accurate results arrived at by his experiments on mechanical friction, a difference which eventually proved to be exactly the error in the British Association unit of resistance; so that the true value of the unit of resistance, or ohm, was determined by Joule 15 years before this result was achieved by electricians. Clerk Maxwell's remarkable electro-magnetic theory of light was put to the test, through the aid of the British Association unit of resistance, by Thomson, in determining the ratio of electro-magnetic unit to the electro-static unit of quantity. Many other most interesting illustrations might be given of the invaluable aid afforded to purely scientific research by the practical results of the development of electrical science, and of the constant co-operation between the science student and the practical worker. No one could, more fitly than the late Sir William Siemens, have maintained, as he did in his admirable address at our meeting in Southampton in 1882, that we owe most of the rapid progress of recent times to the man of science who partly devotes his energies to the solution of practical problems, and to the practitioner who finds relaxation in the prosecution of purely scientific enquiries. Most assuredly both these classes of the world's benefactors may, with equal right, lay claim to rank the name of Siemens among those whom they count most illustrious!

In that highly interesting and valuable address, delivered little more than a year before his sudden untimely removal from among us, the numerous important subjects discussed by him included not a few which he had made peculiarly his own in the wide range embraced by his enviable power of combining scientific research with practical work. Prominent among these were the applications of electric energy to lighting and heating purposes, and to the transmission of power, to the future development of which his personal labours very greatly contributed.

Siemens referred to the passing of the first Electric Lighting Bill, in the year of his presidency, as being designed to facilitate the establishment of electric installations in towns; but the anxiety of the Government of that day to protect the interests of the public through local authorities, led to the assignment of such power to these over the property of lighting companies, that the utilisation of electric lighting was actually delayed for a time by these legislative measures. There can now be no doubt, however, that this delay has really been in the interests of intending suppliers and of users of the electric light, as having afforded time for the further development of practical details, connected with generation and distribution, which was vital to the attainment of a fair measure of initial success. The subsequent important modification of legislation on the subject of electric lighting, together with the practical realisation of comparatively economical methods of distribution, the establishment of fairly equitable arrangements between the public and the lighting companies, and the apportionment, so far as the metropolis is concerned, of distinct areas of operation to different competing companies, have combined to place electric lighting in this country at length upon some approach to a really sound footing, and to give the required impetus to its extensive development. Nine companies either are now, or will very shortly be, actually at work supplying, from central stations, districts of London comprising almost the entire western

* Only that portion of the Address relating to electrical matters has been abstracted.

and north-western portions of the metropolis. As regards other parts of England, there are already 27 lighting stations actually at work in different towns, besides others in course of establishment, and many more projected. The town of Leeds has not failed to give serious attention to the subject of utilising the electric light, and, although no general scheme has yet been adopted, the electricians who now visit this town will rejoice to see many of its public buildings provided with efficient electric illumination.

While the prediction made by Siemens, eight years ago, that electric lighting must take its place with us as a public illuminant, has thus been already, in a measure, fulfilled, important progress is being continuously made by the practical electrician in developing and perfecting the arrangements for the generation of the supply, its efficient distribution from centres, and its delivery to the consumer in a form in which it can be safely and conveniently dealt with and applied at an outlay which, even now, does not preclude a considerable section of the public from enjoying the decided advantages presented by electric lighting over illumination by coal-gas. Yet our recent progress in this direction, encouraging though it has been, is insignificant as compared with the strides made in the application of electric lighting in the United States, as may be gauged by the fact that, while in America the number of arc lamps in use, in April of this year, was 235,000, and of glow lamps about three millions, there are at present about one-tenth the number of the latter, and one hundredth the number of arc lamps, in operation in England.

In some important directions we may, however, lay claim to rank foremost in the application of the electric light; thus, our large passenger ships and our war ships are provided with efficient electrical illumination; to the active operations of our Navy the electric light has become an indispensable adjunct; and our system of coast defence, by artillery and submarine mines, is equally dependent, for its thorough efficiency, upon the applications of electricity in connection with range-finding, with the arrangement and explosion of mines, and with the important auxiliary in attack and defence, the electric light, which, while so arranged, at the operating stations, as to be protected against destruction by artillery-fire and difficult of detection by the enemy, is available at any moment for affording invaluable information and important assistance and protection.

Other important applications of the electric light, such as its use as a lighthouse illuminant, for the lighting of main roads in coal mines, where its value is being increasingly appreciated, and even for signalling purposes in mid-air, through the agency of captive balloons, are continually affording fresh demonstrations of the value of this particular branch of applied electric science.

At the Electrical Exhibition at Vienna, in 1883, where, not long before the lamented death of Siemens, I had the honour of serving as one of his colleagues in the representation of British interests, the progress which had been made in the construction of electrical measuring instruments since the French Exhibition and the Electrical Congress, two years before, was very considerable. The advance in this direction has been enormous since that time; but although the practical result of Thomson's and of Carlew's important work has been to supply us with trustworthy electrical balances and voltmeters, while efficient instruments have also been made by other well-known practical electricians, we have still to attain results in all respects satisfactory in these indispensable adjuncts to the commercial supply and utilisation of electric energy.

In connection with this important subject the recent completion of the Board of Trade standardising laboratory, established for the purposes of arriving at and maintaining the true values of electrical units, and of securing accuracy and uniformity in the manufacture of instruments supplied by the trade for electrical measurements, may be referred to with much satisfaction as a practical illustration of official recognition of the firm root which the domestic and industrial utilisation of electric energy has taken in this country.

The achievements of the telephone were referred to by Siemens in glowing terms eight years ago; but the results then attained were but indications of the direction in which telephonic intercommunication was destined speedily to become one of the most indispensable of present applications of electricity to the purposes of daily life. Preece, in speaking at Bath, two years ago, of the advances made in applied electricity, showed that the impediments to telephonic communication between great distances had been entirely overcome; and now, although considerably behind America and France in the use of the telephone, we are rapidly placing ourselves upon speaking terms with our friends throughout the United Kingdom. The operations of the National Telephone Company well illustrate our progress in telephonic intercommunication: that company has now 22,743 exchange lines, besides nearly 5,000 private lines, its exchanges number 272, and its call-offices 526. The number of instruments under rental in England has now reached 99,000; but, important as this figure is compared to our use of the telephone a very few years ago, it sinks into insignificance by the side of the number of instruments under rental in America, which at the beginning of the present year had reached 222,430, being an increase of 16,675 over the number in 1889. Only thirteen years have elapsed since the telephone was first exhibited as a practically workable apparatus to members of the British Association at the Plymouth meeting, and the number of instruments now at work throughout the world may be estimated as considerably exceeding a million.

The successful transmission of the electric current, and the power of control now exercised over the character which electrically transmitted energy is made to assume, are not alone illustrated by the efficiency of the arrangements already developed for the supply of the electric light from central stations. Siemens dwelt upon this subject at Southampton with the ardent interest of one who had made its development one of the objects of his energetic labours in later years, and also with a prophet's prognostications of its future importance. In speaking of the electric current as having entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope driven by water-power, Siemens pointed out that no further loss of power was involved in the transformation of electrical into mechanical energy than is due to friction, and to the heating of the conducting wires by the resistance they oppose, and showed that this loss, calculated upon data arrived at by Dr. John Hopkinson and by himself, amounted at the outside to 38 per cent. of the total energy. Subsequent careful researches by the Brothers Hopkinson have demonstrated that the actual loss is now much less than it was computed at in 1885; as much as 87 per cent. of the total energy transmitted being realisable at a distance, provided there be no loss in the connecting leads used.

The Paris Electric Exhibition of 1881 already afforded interesting illustrations of the performance of a variety of work by power electrically transmitted, including a short line of railway constructed by the firm of Siemens, which was a further development of the successful result already attained in Berlin by Werner Siemens in the same direction, and was, in its turn, surpassed by the considerably longer line worked by Messrs. Siemens at the Vienna Exhibition two years later. Various short lines which have since then been established by the firm of Siemens are well known, and one of the latest public acts in the valuable life of Siemens was to assist at the opening of the electric tramway at Portrush, in the installation of which he took an active part, and where the idea, so firmly rooted in his mind from the date of his visit to the Falls of Niagara, in 1876, of utilising water-power for electrical transmission—a result first achieved on a small scale by Lord Armstrong—was more practically realised than had yet been the case. Since that time Ireland has witnessed a further application of electricity to traction purposes, and of water-power to the provision of the required energy, in the working of the Bessbrook and Newry tramway, while London at length possesses an electric railway, three miles in length, to be very shortly opened, which will connect the City with one of the southern suburbs through a tram subway, and, although including many sharp curves and steep gradients, will be capable of conveying one hundred passengers at a time, at speeds varying from thirteen to twenty-four miles per hour. During the past year a regular service of tramcars has been successfully worked, through the agency of secondary batteries, upon part of one of the large tramways of North London, with results which bid fair to lead to an extensive development of this system of working. The application of electricity to traction purposes has, however, received far more important development in the United States; at the commencement of this year there were in operation in different States 200 electrical tramroads, chiefly worked upon the Thomson-Houston and the Sprague systems, and having a collective length of 1,641 miles, with 2,346 motor-cars travelling thereon. Further extensions are being rapidly made: thus, one company alone has 39 additional roads, of a collective length of 385 miles, under construction, to be worked through the agency of storage-batteries.

The idea cherished by Siemens, and enlarged upon by him in more than one interesting address, of utilising the power of Niagara, appears about to be realised, at any rate in part; as a large tract of land has been recently acquired, by a powerful American association, about a mile distant from the Falls, with a view to the erection of mills for utilising the power, which it is also proposed to transmit to distant towns; and an International Commission, with Sir William Thomson at its head, and with Mascart, Turrettini, Coleman Sellers, and Unwin as members, will carefully consider the problems involved in the execution of this grand scheme.

The application of electric traction to water-traffic, first successfully demonstrated in 1883, is receiving gradual development, as illustrated by the considerable number of pleasure-boats which may now be seen on the Upper Thames during the boating season, and in connection with which Professor George Forbes proposed, at our meeting last year, that stations for charging the requisite cells, through the agency of water-power, should be established at the many weirs along the river, so as to provide convenient electric coaling-stations for the river pleasure-fleet.

Electrically-transmitted energy was first applied in Germany to haulage work in mines by the firm of Siemens some years ago, and great progress has since been achieved herein on the Continent and in America. Comparatively little has been accomplished in this direction in England; but it is very interesting to note, on the present occasion, that the first successful practical application of electricity in this country to pumping and underground haulage-work was made in 1887, in this neighbourhood, at the St. John's Colliery, at Normanton, where an extensive installation, carried out by Mr. Immisch, so well known in connection with electric launches, is furnishing very satisfactory results in point of economy and efficiency. The gigantic installations existing for the same purposes in Nevada and California afford remarkable illustrations of the work to be accomplished in the future by electrically-transmitted energy.

Among the many subjects of importance studied by Joule with the originality and thoroughness characteristic of his work, was the application of voltaic electricity to the welding and fusion of

metals. Thirty-four years ago he published a most suggestive paper on the subject, in which, after dealing with the difficulties attending the operation of welding, and of the interference of films of oxide, formed upon the highly heated iron surfaces, with the production of perfect welds either under the hammer or by the methods of pressure (of which he then predicted the application to large masses of forged iron), he refers to the possibility of applying the calorific agency of the electric current to the welding of metals, and describes an operation witnessed by him in the laboratory of his fellow-labourer, Thomson, of fusing together a bundle of iron wires by transmitting through them, when imbedded in charcoal, a powerful voltaic current. Joule afterwards succeeded in fusing together a number of iron wires with the current of a Daniell battery, and of welding together wires of brass and steel, platinum and iron, &c. In discussing the question of the amount of zinc consumed in a battery for raising a given amount of iron to the temperature of fusion, he points out that the same object would probably be more economically attained by the use of a magneto-electric machine, which would allow the heat to be provided by the expenditure of mechanical force, developed in the first instance by the expenditure of heat; and he indicates the possibility of arranging machinery to produce electric currents which shall evolve one-tenth of the total heat due to the combustion of the coal used, so that 5,000 grains of coal applied through that agency would suffice for the fusion of one pound of iron. The successful practical realisation of Joule's predictions in regard to the application of electric currents, thus developed, to the welding of iron and steel, and to analogous operations, through the agency of the efficient machines devised by Prof. Elihu Thomson, was demonstrated to the members of the Association by Prof. Ayrton at Bath two years ago, and was shown upon a larger scale to visitors at the Paris Exhibition last year, and recently to highly-interested audiences in London by our late President, Sir Frederick Bramwell. The latter demonstrated that the production of iron welds by means of the Thomson machines was accomplished nearly twice as rapidly as by expert craftsmen; the perfection of the welds being proved by the fact that the strength of bars broken by tensile strains at the welds themselves was about 92 per cent. of the strength of the solid metal. At the Crewe Works, Mr. Webb is successfully applying one of these machines to a variety of welding work. The rapidity with which masses of metal of various dimensions are raised in those machines to welding heat is quite under control; the heat is applied without the advent of any impurities, as from fuel, and the speed of execution of the welding operation reduces to a minimum the time during which the heated surfaces are liable to oxidise. With such practical advantages as these, this system of electric welding bids fair to receive many useful applications.

Another very simple system of electric welding, especially applicable to thin iron and steel sheets, hoops, &c., has been contemporaneously elaborated in Russia by Dr. Bernados, and is already being extensively used. The required heat at the surfaces to be welded is developed by connecting the metal with the negative pole of the dynamo machine, or of a battery of accumulators, the circuit being completed by applying a carbon electrode to the parts to be heated; the reducing power of the carbon is said to preserve the heated metal surfaces from oxidation during the very brief period of heating. This mode of operation appears to have been practised upon a small scale, some years ago, by Sir William Siemens, to whom we also owe the first attempt to practically apply electric energy to the smelting of metals.

In his address in 1882 he referred to some results attained with his small electrical furnace, and pointed out that, although electric energy could, obviously, not compete economically with the direct combustion of fuel for the production of ordinary degrees of heat, the electric furnace would probably receive advantageous application for the attainment of temperatures exceeding the limits (about 1,800° C.) beyond which combustion was known to proceed very sluggishly. This prediction appears to have been already realised through the important labours of Messrs. Cowles, who some years ago attacked the subject of the application of electricity to the achievement of metallurgic operations with the characteristic vigour and fertility of resource of our Transatlantic brethren. After very promising preliminary experiments, they succeeded, in 1885, at Cleveland, Ohio, in maturing a method of operation for the production of aluminium bronze, ferro-aluminium and silicium-bronze, with results so satisfactory as to lead to the erection of extensive works at Lockport, N.Y., where three dynamo machines, each supplying a current of about 3,000 ampères, are worked by water power, through the agency of turbines, each of 500 H.P., 18 electric furnaces being now in operation for the production of aluminium alloys. These achievements have led to the establishment of similar works in North Staffordshire, where a gigantic dynamo machine has been erected, furnishing a current of 5,000 ampères, with an E.M.F. of 50 to 60 volts. The arrangement of the electrodes in the furnaces, the preparation of the furnace charges (consisting of mixtures of aluminium ore, with charcoal and with the particular granulated metal with which the aluminium is to become alloyed at the moment of its elimination from the ore); the appliances for securing safety in dealing with the current from the huge dynamo machine, and many other details connected with this new system of metallurgic work, possess great interest. Various valuable copper and aluminium alloys are now produced by alloying copper itself with definite proportions of the copper alloy, very rich in aluminium, which is the product of the electric furnace. The rapid production in large quantities of ferro-aluminium—which presents the aluminium in a form suitable for addition in definite proportions to fluid cast iron and steel—is another useful outcome of the practical development of the electric furnace by Messrs. Cowles.

Great interest attaches to the influence of the metals manganese, chromium, and tungsten upon the physical properties of steel and iron.

The curious effect of manganese in reducing, and even destroying, the magnetic properties of iron was already noticed by Rinman nearly 120 years ago; one result of Hadfield's important labours has been to place in the hands of such eminent physicists as Thomson, John Hopkinson, and Reinold, materials for the attainment of most interesting information respecting the electrical and other physical characteristics of manganese steel. Hopkinson, from experiments with a sample of steel containing 12 per cent. of manganese, estimated that not more than 9 out of the 86 per cent. of the iron composing the mass was magnetic, and he considered that the manganese enters into that which must, for magnetic purposes, be regarded as the molecule of iron, completely changing its properties, a fact which must have great significance in any theory regarding the nature of magnetisation.

NEW PATENTS—1890.

12532. "Improvements in electric lighting." S. PITT. (Communicated by Sautter Harlé and Co., France.) Dated August 11. (*Complete.*)

12628. "Improvements relating to the welding of metals by electricity." H. E. FOWLER. Dated August 12. (*Complete.*)

12634. "Improvements in dynamo-electric machines or electric motors." T. M. FOOTE. Dated August 12. (*Complete.*)

12713. "Improvements in electric mains, and in apparatus used in their manufacture." S. Z. DE FERRANTI. Dated August 13.

12819. "Improvements in column type printing instruments operated electrically, for telegraphic and other purposes, and in conductors therefor, which latter also applicable for telephonic and electric transmission generally." S. D. WILLIAMS. Dated August 15.

12827. "Improvements in armatures for dynamo-electric machines." H. J. HILTON. Dated August 15.

12830. "Improvements in secondary batteries, and electrodes therefor." H. H. LAKE. (Communicated by G. A. Johnson and S. L. Holdredge, United States.) Dated August 15. (*Complete.*)

12832. "An electrical watt meter, also applicable as an ammeter or voltmeter." E. WILSON. Dated August 15.

12874. "Improved electric switch." C. R. BONNE. (Communicated by The Actien Gesellschaft Mix and Genest, Germany.) Dated August 16.

12914. "Improvements in switches for controlling and regulating double or compound electric motors, especially applicable to traction or marine propulsion." A. J. JARMAN. Dated August 18.

12915. "Improvements in brush holders for dynamo-electric motors and generators." A. J. JARMAN. Dated August 18.

12958. "Improvements in apparatus for effecting, by insertion of a coin, the production of electric light for a certain time." D. H. DAVIES and J. M. TOURTEL. Dated August 18.

12997. "An improved electrical rock drill, coal digger, or earth cutter." W. B. BRAIN, A. J. ARNOT, and F. BAKER. Dated August 19. (*Complete.*)

13002. "Improvements relating to induction coils or transformers chiefly designed for use in welding or otherwise working metal by electricity." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated August 19. (*Complete.*)

13003. "Improvements in the manufacture of electrodes for primary and secondary batteries." D. PEPPER, jun. Dated August 19. (*Complete.*)

13006. "Improvements in welding or otherwise working metals by electricity, and in apparatus therefor." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated August 19. (*Complete.*)

13009. "Improvements in printing telegraphs." J. B. ODELL. Dated August 19. (*Complete.*)

13013. "Improvements in the manufacture of electrodes for primary and secondary batteries." D. PEPPER, jun. Dated August 19. (*Complete.*)

13042. "Improvements in or appertaining to electric railway systems." C. J. VAN DEPOELE. Dated August 19. (*Complete.*)

13044. "A new or improved method and apparatus for effecting economy of electric force in electric writing." P. E. BARDONNAUT and P. JUPPONT. Dated August 19. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, 20th February, 1890, being date of application in France.]

13049. "Improvements in electric telegraphs, in part applicable for signalling on racecourses and elsewhere." F. E. MACMAHON. Dated August 19.

13129. "Improvements in safety fuses or cut-outs for electrica circuits." A. W. SLATER. Dated August 21.

13164. "Improvements in means and apparatus for adjusting electric suspending lights, and for other like purposes." A. LUCAS and E. SUNDBORG. Dated August 21.

13171. "Improvements in fittings for incandescent electric lamps." L. HOEPL and E. COURTIN. Dated August 21.

13175. "Improvements in miners' electric safety lamps." W. PETO. Dated August 21.

13187. "Improvements in electro-motors." R. F. MOORE. Dated August 21. (*Complete.*)

13190. "Improvements in exciting electro-magnets and electro-magnetic machinery." R. KENNEDY. Dated August 22. (*Complete.*)

13212. "Improvements in electric accumulators." R. DEYSDALE. Dated August 22.

13233. "Improvements in portable electric lamps, more especially intended for miners' use." THE MINING AND GENERAL ELECTRIC LAMP COMPANY, LIMITED, and W. MOSCROP. Dated August 22. (*Complete.*)

13276. "Improvements in covering wires to protect them from corrosion, especially applicable to electrical conductors." E. SHIN. Dated August 23.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

11032. "Improvements in electric meters." J. OULTON and J. EDMONDSON. Dated July 9. 8d. Consists in the mode of regulating the time of rotation of "torsion balances" in electric meters. The inventors attach the torsion ribbon (by which such balances are suspended) to the stem of a screw, or to a lever by which it is raised or lowered through a curb, such raising or lowering shortens or lengthens the acting portion of the ribbon and thus increases or lessens the speed of rotation as may be required. 7 claims.

11419. "Improvements in electric meters." SIEMENS BROTHERS & Co. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 16. 8d. The apparatus consists essentially of a light arm or lever having a suitably curved face which is caused by clockwork to be turned on its axis at regular intervals of time from a stated rest until it meets the end of a pointer, the position of which is determined by the strength of the current, such angular motion of the arm being transmitted to the wheel work of a counter or registering mechanism. 6 claims.

11425. "Improvements in regulating apparatus for electric arc light lamps." E. FISCHINGER. Dated July 16. 8d. Two electro-magnets are employed, the winding of which magnets is made of fine wire, in derivation from, or parallel to the main circuit, and in combination with these electro-magnets, mechanical devices are employed, by which the armatures of the said electro-magnets will cause the approach of the two carbons for making contact, the separation of the carbons for creating the arc, and the regulation of the position of the two carbons relatively to each other in a quiet and accurate manner. 1 claim.

11519. "Improvements in roses for supporting electric lamps." C. W. FARQUHAR and H. L. DOULTON. Dated July 18. 6d. The inventors make roses for supporting electric lamps in three pieces, A, B, and C. The piece, A, is cemented, screwed or otherwise fixed to the ceiling or wall from which the lamp is to be supported. At the centre it is provided with a projection of a disc like form with a screw thread around its edge. This disc is perforated for the leads to be passed through. The piece B rests against A; it is also perforated to receive the conductors attached to the lamp. The junctions between these and the leads are made between the pieces A and B and are thus concealed. The piece, C, consists of a screw cap which screws on to the piece A, and holds the piece B in position. 2 claims.

11997. "Improvements in electric meters." W. EMMOTT and W. ACKROYD. Dated July 29. 6d. A receiver over the electrodes and dipping into the electrolyte is connected with a closed vessel containing liquid. This closed vessel communicates with the outside by means of a safety tube dipping into the liquid, and is also provided preferably with a syphon. Each time a given amount of gas is liberated by electrolysis, the liquid in the closed vessel is forced up the syphon and also up the safety tube until the bottom of the safety tube is exposed when a quantity of gas is at intervals forced out of the safety tube. The force of this escape is utilised to measure the amount of electricity by means of a mechanical or other suitable device. 2 claims.

13149. "Improvements in apparatus for obtaining reciprocating motion from electric currents, applicable to the operation of electric bells, hammers, caulking tools or the like." T. PARKER. Dated August 20. 6d. The inventor includes in the operating circuit a pair of coils, or their equivalents, by which the hammer, or part to be reciprocated, is moved alternately in opposite directions, the said hammer or part acting upon a switch with scraping or rubbing contacts so arranged that after the reciprocating hammer or moving part is attracted in one direction it causes the switch to make contacts to break the circuit to the coil which attracted the hammer or moving part and complete the circuit through the opposite coil, and so on during the operation of the device. 3 claims.

13282. "Improvements in electric lamps, and means for securing electric lamps in carriages and like vehicles." G. F. SLATTER. Dated August 22. 8d. Claims:—1. Supporting the platinum wires and the filament of an incandescent electric lamp from within the lamp, said support being independent of the usual end support as set forth. 2. The double suspension appliances of an electric incandescent lamp and of its attachments as means for subdueing vibrations of the lamp and for preventing oscillation of the filament as set forth. 3. Fixing an India-rubber sheet web and attaching an incandescent electric lamp frame thereto as a means for suspending an electric incandescent lamp in or from a carriage as and for the purposes set forth.

13838. "Improvements in means or devices for use in the distribution of electrical currents." A. W. HEAVISIDE and R. C. JACKSON. Dated September 2. 8d. The objects of the invention are to provide devices which furnish adequate means for localising faults in underground mains, and give protection to the mains and submains from over pressure by means of fuses conveniently situated at the distributing points. The invention also gives great facilities for insulating joints in mains so that the insulation need not be disturbed each time a test has to be made and further also facilities for cross connecting mains so as to make a good main relieve a defective one, or to alter the distribution of electric energy so as to meet varying needs. 10 claims.

14086. "Improved means for effecting the insulation of electrical transformers, switches, switchboards, fuses, commutators, and commutator brushes." W. C. JOHNSON and S. E. PHILLIPS. Dated September 6. 8d. Has mainly for its object to obtain a better insulation of electrical transformers, switches, switch boards, fuses, commutators and their brushes, and it consists in immersing these apparatus in, or surrounding them by, a non-conducting liquid, such as mineral oil, or other suitable liquid whereby they are protected from the atmosphere, and at the same time sparks that may be produced are immediately extinguished, and any tendency to form an arc is greatly lessened. 1 claim.

CORRESPONDENCE.

Cable Testing.

In 1884 I had occasion to use some quick method of finding weak places and bad faults in electric light cables having very heavy conductors, such as strands of 19 No. 6 wires, weighing nearly 12,000 lbs. per mile. My method was as follows:—

Put a drum with a cable coiled on it on an insulated stand, fastening the inside end of the cable to the spindle on which the drum revolves so that there is good rubbing contact, take the outside end to another drum a few feet away also insulated. Now, attach one end of a battery of 300 Leclanché cells to the spindle of the full drum, the other end being "to earth." Having done this, take a man (one peaceably inclined for preference), put a piece of wet cotton-waste in his hand and let him grasp the cable (which must be hauled from the full drum on to the empty one by an insulated man) so that every inch passes through his hand; when the fault comes, if you pick out a nice damp place for the uninsulated man to stand on, he will let you know at once without previous instructions. I had to forego this method owing to a scarcity of the proper sort of men in our locality.

I then tried placing a shunted reflecting galvanometer in the circuit, putting the man on insulators, and this acted perfectly. The especial merit of the above method is, that in the case of a hemp braided cable, such as I was manufacturing then, there is no need to cut the braiding and tapings except at the exact spot where the fault lies; of course the external coverings of the cable must be moderately dry.

Basil Gee,
Late Works Manager and Electrician to Callender's Company, Limited.

Fusible Cut-Outs in Armatures.

Can any of your readers kindly inform me of any instance where fusible wire has been used in connecting the sections of a gramme armature to the segments of the commutator, the connecting wire acting as a fusible cut-out in case of two segments of the commutator becoming short circuited.

E. J. M.